NAS7.000817
NASA - JPL
SSIC No. 9661

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Field Sampling and Analysis Plan for Performing a Remedial Investigation at Operable Unit 2: Potential On-Site Contaminant Source Areas

National Aeronautics and Space Administration Jet Propulsion Laboratory

4800 Oak Grove Drive
Pasadena, California 91109

EBASCO ENVIRONMENTAL

DECEMBER 1993

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LIST OF ACRONYMS

CCL_4	Carbon Tetrachloride
CalEPA	California Environmental Protection Agency
CalTech	California Institute of Technology
CDHS	California Department of Health Services
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFM	Cubic Feet Per Minute
CI	Cast Iron
DQOs	Data Quality Objectives
DTSC	Department of Toxic Substances Control
DW	Dry Well
EB	Equipment Blank
ECD	Electron Capture Detector
ELCD	Electrolytic Conductivity Detector
EPA	Environmental Protection Agency
FFA	Federal Facilities Agreement
FID	Flame-Ionization Detector
FS	Feasibility Study
FSAP	Field Sampling and Analysis Plan
GALCIT	Gugenhiem Aeronautical Laboratory, California Institute of Technology
GC	Gas Chromatograph
HASP	Health and Safety Plan
ID	Inside Diameter
JPL	Jet Propulsion Laboratory
M50	Trichloroethane
MDL	Method Detection Limit
MW	Monitoring Well
NA	Not Analyzed or Not Applicable
NASA	National Aeronautics and Space Administration
NPL	National Priorities List
OU-1	Operable Unit - 1
OU-2	Operable Unit - 2
OU-3	Operable Unit - 3

LIST OF ACRONYMS

(Continued)

PCB	Polychlorinated Biphenyls
PCE	Tetrachloroethene (Perchloroethene)
PID	Photo-ionization Detector
PVC	Polyvinyl Chloride
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RWQCB	California Regional Water Quality Control Board, Los Angeles Region
SB	Soil Boring
SI	Site Inspection
SS	Soil Sample
SV	Soil Vapor
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
UHP	Ultra-High-Purity
VC	Vitrified Clay
VES	Vapor Extraction System
VOCs	Volatile Organic Compounds
VP	Vapor Probe
WIP	Well Investigation Program

1.0 INTRODUCTION

This Field Sampling and Analysis Plan (FSAP) is one of the documents that will be used to implement the Remedial Investigation (RI) sampling and analysis program at National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory (JPL) in Pasadena, California (Figure 1-1). The term "JPL" is used throughout this document to refer to the facilities located at 4800 Oak Grove Drive in Pasadena, California.

NASA's Jet Propulsion Laboratory is currently subject to the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, since being placed on the National Priorities List (NPL) in October, 1992. This FSAP is the second of three to be produced, one each associated with the three operable units agreed upon by the United States Environmental Protection Agency (Region 9) (EPA), the California State Department of Toxic Substances Control (DTSC), the California Regional Water Quality Control Board - Los Angeles Region (RWQCB), and NASA.

The activities presented in this FSAP will be executed in support of the Remedial Investigation (RI) of Operable Unit 2 (OU-2), potential on-site contaminant source characterization. Operable Unit 1 (OU-1) pertains to the on-site groundwater operable unit, and Operable Unit 3 (OU-3) to the off-site groundwater characterization. The boundary between on-site groundwater OU-1 and off-site groundwater OU-3 is illustrated on the site facility map in Figure 1-2.

This FSAP has been prepared using the EPA document "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (OSWER Directive 9355.3-01, Interim Final, October, 1988) and meets all applicable CERCLA, State of California and Federal Facility Agreement (FFA) requirements. This FSAP contains discussions of site background (Section 2.0), sampling objectives (Section 3.0), sample locations and frequency (Section 4.0), sample designation (Section 5.0), sampling equipment and procedures (Section 6.0), sample handling and analysis (Section 7.0), and references (Section 8.0).

A detailed description of the site background along with descriptions of the conceptual model that led to the development of the OU-2 FSAP is presented in the Remedial Investigation/Feasibility Study (RI/FS) Work Plan. In addition to this information, the Remedial Investigation (RI) and Feasibility Study (FS) objectives are described along with the rationale used as a basis for the proposed work. Other information presented in the work plan includes a description of RI/FS tasks, cost and key assumptions of the RI/FS work, schedule, and project management roles.

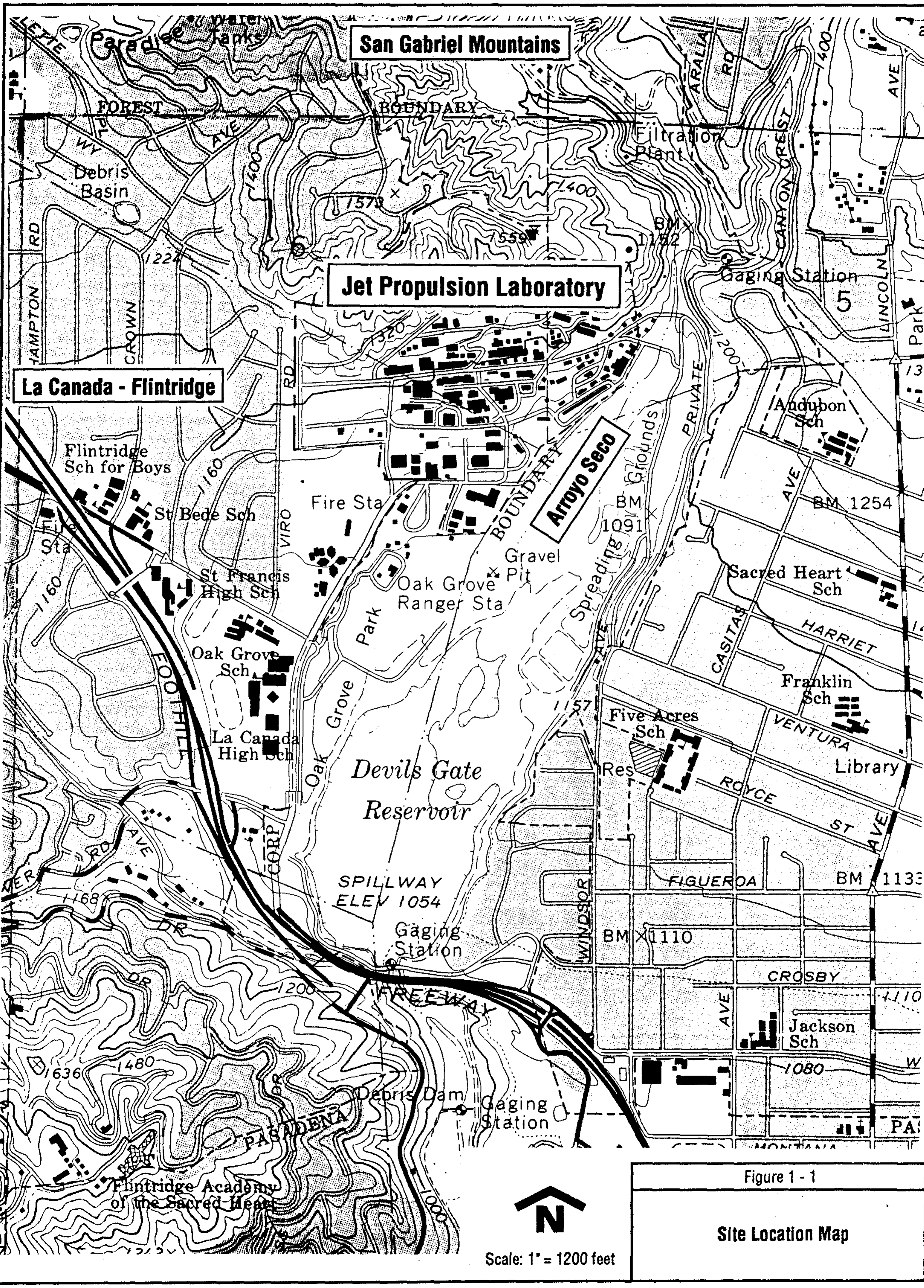


Figure 1 - 1

Site Location Map

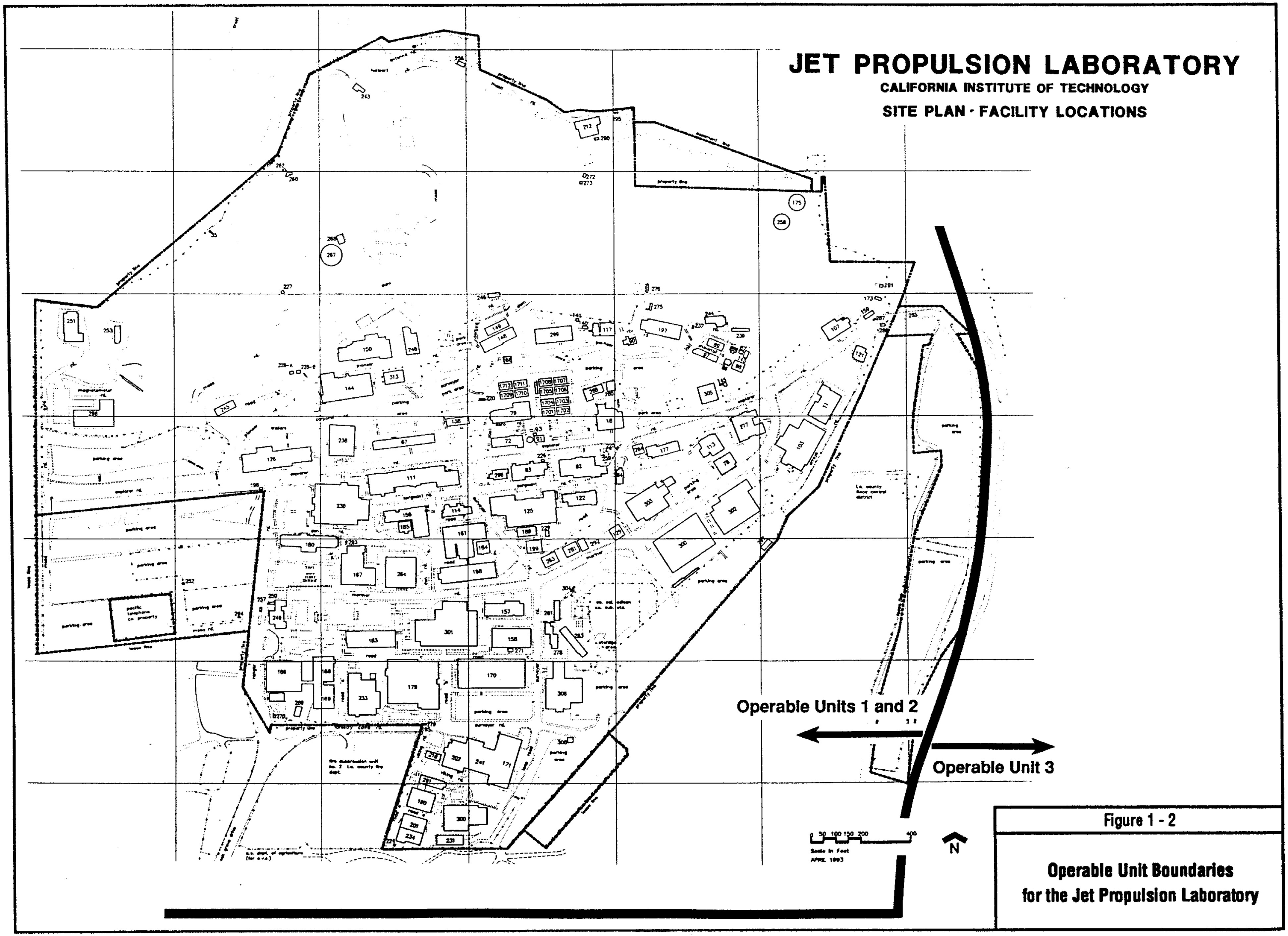


Figure 1 - 2

Operable Unit Boundaries for the Jet Propulsion Laboratory

2.0 SITE BACKGROUND

JPL is located within the cities of Pasadena and La Canada-Flintridge, California, northeast of the 210 Foothill Freeway. The site covers 176 acres and is situated at the base of the southern edge of the San Gabriel Mountains (Figure 1-1). The Arroyo Seco, an intermittent stream bed, lies immediately to the east and southeast of the site. Residential development borders the western boundary of the site.

In 1936, Professor Theodore Von Karmen of the California Institute of Technology (CalTech) and a group of students began testing liquid propellant rockets in the Arroyo Seco. At that time the work was being completed through CalTech's Gugenhiem Aeronautical Laboratory (GALCIT). In 1940, the Army Air Corps provided funding and the first permanent structures were built near the present day site. By 1944, the site continued to grow and changed its name to the Jet Propulsion Laboratory, GALCIT. Ultimately, the site became known as the Jet Propulsion Laboratory, or JPL, and became a fully owned Federal facility. In 1958, the National Aeronautics and Space Administration (NASA) took over control of JPL. Today, under a prime contract, CalTech performs research and development tasks at facilities provided by NASA and which are located at the current day site of JPL. CalTech also maintains the facilities as part of its contractual agreement with NASA.

Chemicals and materials with a variety of contaminant properties are, and have been utilized during the operational history of JPL. The general types of materials used and produced, now and in the past, include a variety of solvents, solid and liquid rocket propellants, cooling-tower chemicals, and chemical laboratory wastes. During the 1940s and 1950s, nearly every building at JPL maintained a cesspool to dispose of liquid and solid sanitary wastes collected from drains and sinks within that building. These cesspools were designed to allow liquid wastes to seep into the surrounding soil. Present-day terminology for these subsurface disposal areas is "seepage pits", and that term is used in this FSAP. Although the seepage pits were abandoned in the late 1950s and early 1960s when a sewer system was installed, some of the seepage pits may have received volatile organic compounds (VOCs) and other waste materials that are currently found in the groundwater.

In 1980, analyses of groundwater from three City of Pasadena water-supply wells located near JPL indicated concentrations of trichloroethene (TCE), tetrachloroethene (PCE) and carbon tetrachloride (CCl_4) above drinking water standards. Over the past 13 years a number of investigations focusing on geotechnical and environmental issues have been conducted at JPL. A detailed review of previous investigations at the site is presented in the RI/FS Work Plan.

In October 1992, JPL was included on the National Priorities List (NPL) and in December 1992, EPA, NASA, DTSC, and RWQCB entered into a Federal Facilities Agreement (FFA). The components of the field sampling program in this FSAP are designed to follow requirements set forth in the FFA.

The following is a brief summary of the site setting. JPL is situated on a relatively steep alluvial slope at the southern edge of the San Gabriel Mountains and at the northern edge of the San Gabriel Valley. A series of east-west trending and north dipping thrust faults, referred to as the Sierra Madre Fault system, separate the mountains from the valley. Beneath JPL the alluvial deposits range in thickness from 650 to 850 feet. The alluvial deposits rest on a crystalline basement complex made up of the same general rock types as those comprising the San Gabriel Mountains. The vadose zone ranges between 100 to 250 feet in thickness and the saturated alluvium forms a water-table aquifer ranging between 550 and 600 feet in thickness. The regional groundwater flow gradient is generally from JPL toward the southeast. However, the groundwater flow direction and gradient below JPL can occasionally change significantly. Nearby City of Pasadena municipal water production wells and the Arroyo Seco spreading grounds, used for groundwater recharge, can have large influences on the local groundwater table.

3.0 SAMPLING OBJECTIVES

The overall goal of this sampling and analysis program is to contribute to the successful completion of the RI and provide the data needed to select a remedial alternative in the FS. To achieve these goals, the program outlined in this FSAP must effectively assess the nature and extent of contaminants at potential contaminant source areas within the JPL site boundaries. A number of objectives for this program have been developed that will assist in reaching these goals. The sampling objectives for OU-2 are the following:

- Investigate potential source areas and determine which ones are, or potentially could, impact groundwater.
- Assess the variation and extent of soil contaminants.
- Identify volatile organic compound hot spots.
- Determine background levels for metals in soil.
- Establish the organic vapor distribution in the vadose zone to be used in the potential design of remedial actions.
- Provide data on soil contamination to aid in determining the design and potential efficiency for any remedial actions.

4.0 SAMPLE LOCATIONS AND FREQUENCY

Soil-vapor and soil sample locations have been chosen to satisfy program sampling objectives and obtain information to characterize potential contaminant source areas. The locations have been selected based on information from previous investigations including records research, interviews with current and former facility personnel, and the history of waste-disposal practices. During JPL's history, facility changes have occurred and may have influenced the subsurface. The uncertainties about precise disposal locations have made it necessary to use several sampling methods to achieve program goals.

The program to identify and characterize potential contaminant source areas will begin with a shallow soil-vapor survey. Pending analytical results, additional step-out soil-vapor probes may be installed at selected sites. All soil-vapor probes installed will be semi-permanent to allow for resampling on a preapproved periodic basis if needed. Following the conclusion of the initial soil-vapor surveys, a soil-boring and sampling program will be conducted at each accessible potential contaminant source area to evaluate non-volatile contaminants of concern at JPL. Nested soil vapor monitoring wells will be installed in two of the soil borings at locations that had the most elevated concentrations of volatile organic compounds (VOCs).

Descriptions of the potential contaminant source locations at JPL are presented in Section 4.1. The locations where soil-vapor samples will be collected are discussed in Section 4.2, and the rationale and locations for additional step-out soil-vapor probes is discussed in Section 4.3. Details on the placement, design, and construction of nested soil vapor monitoring wells are given in Section 4.4. The rationale, frequency, and types of analyses required for soil sampling is presented in Section 4.5.

4.1 POTENTIAL CONTAMINANT SOURCE AREAS

After reviewing reports of previous investigations and interviewing long-time and retired employees of JPL, there is evidence that the groundwater contamination present today may be the result from waste generation and disposal practices used in the 1940s and 1950s. During this time period, seepage pits (cesspools) were used to dispose of liquid and solid wastes from lavatories, drains, and sinks at many JPL buildings. These seepage pits were designed to allow liquid wastes to seep into the surrounding soil. Many of these seepage pits may have received various quantities of chemicals used at the facility. Although the seepage pits were abandoned in the late 1950s and early 1960s when a sewer system was installed, a number of these seepage pits may be the original source of contaminants currently detected in the groundwater. From a review of JPL facility records and interviews with current and former employees, seepage pits or dry wells have been identified at the locations shown in Figure 4-1.

In addition to the seepage pits, other localized sources appear to be present. It was learned during the interviews that an erosion channel near Building 103 was reportedly used for intermittent disposal of small amounts of liquid wastes, and, possibly, some mercury at one time. The location of this area is designated as WP-1 in Figure 4-1. In the late 1940s and early 1950s, a wide shallow depression bulldozed in the Arroyo Seco was used for disposing of solid-wastes, which were reported to be mainly glass and metal shavings. This area is designated as WP-2 in Figure 4-1. During the late 1950s, two or three hand-dug holes about 4 feet across and 3 feet deep, approximately 25 feet apart, were reportedly used for 2 to 3 years to dispose of solvents southeast of existing Building 248. Approximately three 55-gallon drums of solvents, at varying concentrations, were reportedly dumped into the holes every 3 or 4 months. This area is designated as WP-3 in Figure 4-1. In 1991, approximately 19,000 tons of soil contaminated with petroleum hydrocarbons were encountered during excavation operations for Building 306's first floor and foundations. These areas are described in greater detail in the RI/FS Work Plan and in the following subsections.

Seepage and Waste Pit Descriptions

Information on the procedures used to locate and identify the seepage and waste pits is presented in Section 5.1.11 of the RI/FS Work Plan. Below are descriptions of each of the identified seepage and waste pits, and another potential contaminant source area in the vicinity of Building 306.

<u>Seepage Pit Nos. 1 and 2</u>

These two seepage pits were connected in tandem and were used to dispose of liquid wastes from former Buildings 3, 14, 17, and 22 and sanitary wastes from Building 19. Locations of these five buildings, the seepage pits, and drain lines are shown on a pre-1949 drawing prepared by the U.S. Army titled "Master Plumbing Plan for East Portion." This plan was designated as Drawing No. JPL0901A-0. Names for these buildings are not shown on the drawing, and records regarding their use are very limited.

Construction drawings for Buildings 3, 14, 17, and 22 do not exist. However, it is speculated that the seepage pits were not used for sanitary-waste disposal since the drain lines from each of these buildings consisted of 2-inch-diameter cast iron pipe that extended long distances before joining with a 4-inch-diameter vitrified clay pipe. A 4-inch-diameter cast iron pipe

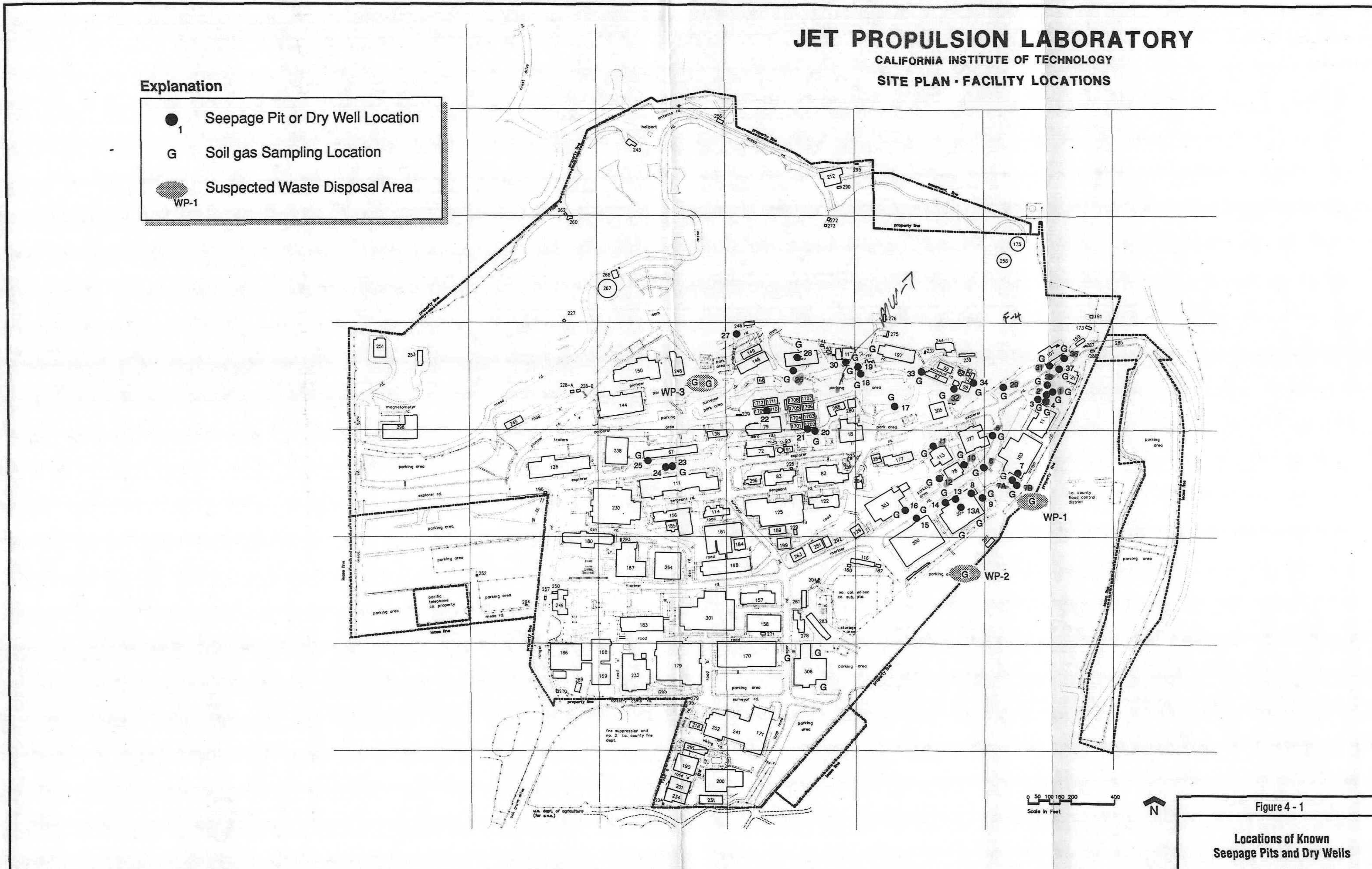


Figure 4 - 1

Locations of Known Seepage Pits and Dry Wells

extends from Building 19 to the vitrified clay pipe indicating that restrooms were probably inside this building. Details on the construction of the pits are not available.

Seepage Pit Nos. 3 and 4

Seepage Pit Nos. 3 and 4 were constructed in tandem along the north side of existing Building 11 at the locations shown on JPL Drawing No. JPL0901A-0 and used to dispose sanitary wastes from restrooms and a small "kitchen area" (JPL Drawing No. 11/1-0). Drain lines from these rooms consist of 4-inch-diameter cast iron pipe that extend a few feet outside of the building before joining with a 4-inch-diameter vitrified clay pipe leading to the seepage pits.

Building 11 was originally designed to house the administrative and engineering offices for the facility and was maintained for these functions a number of years. The building was modified extensively in 1951, and it is indicated on JPL Drawing No. 11/81-0 that Seepage Pit Nos. 3 and 4 may have been abandoned at that time. Restrooms were moved to the south side of the building and connected by cast iron and vitrified clay pipes to other existing seepage pits. Locations of these other seepage pits are neither dimensioned nor shown to scale in relation to the building on any available drawing. Hence, their exact locations have not been determined. However, details on JPL Drawing No. 11/81-0 indicate that the pits were constructed with unmortared brick and had a minimum depth of 15 feet.

Prior to 1960, Building 11 was converted to house electrical and plumbing shops and related storage areas for supplies. Solvents are routinely used in repairing, cleaning, and maintaining electrical and plumbing equipment, hardware, tools, and machinery.

Seepage Pit No. 5

The location of Seepage Pit No. 5 was on the south side of former Building 127 and received sanitary wastes from this building and similar wastes from former Buildings 68 and 71 according to plumbing details on JPL Drawing Nos. 71/1-0 and JPL0901A-0. Seepage Pit No. 5 received wastes from Buildings 71 and 127 via a 4-inch-diameter vitrified clay pipe. A 4-inch cast iron pipe tied into that line from Building 127. A 6-inch-diameter vitrified clay pipe was used to convey wastes from Building 68 to the seepage pit. Construction details on the seepage pit are not available.

Building 68's function and use is unknown since there are no records for this building in the JPL files. Building 71 was originally used for shipping and receiving at the facility and was later converted to "mechanics stores." Building 127 is believed to have been used for vehicle maintenance since details on JPL Drawing No. 71/1-0 indicate long manway pits for lubricating the underside of vehicles and the location of an Autolite sparkplug cleaner.

All three buildings are located in close proximity to old solid-propellent bunkers and may have been used intermittently to store chemicals and solvents used in the mixing and development of propellants.

Seepage Pit No. 6

The location for this seepage pit is shown on Drawing No. JPL0901A-0 only, and no piping is shown to indicate which building it may have served. However, since Seepage Pit No. 6 was located in an area where surrounding seepage pits (Nos. 5, 7, 7A, 7B, 8, 9, and 10) are suspected to be potential sources of chemical or solvent contaminants, it could also be a potential contaminant source.

Seepage Pit Nos. 7, 7A, and 7B

Seepage Pit No. 7 was installed about 15 feet south of the original Building 103, a machine shop in which oils, solvents, and chemical degreasers were used. Additions to the building were built over Seepage Pit No. 7 and necessitated the construction of two additional seepage pits (7A and 7B) farther south. The locations of pits 7A and 7B are shown on JPL Drawing 103/7-0. All three seepage pits were designed to collect sanitary wastes from restrooms.

Building 103 housed a machine shop, metal fabrication shop, and a metal pickling room. Solvents were and still are used routinely for cleaning and degreasing. It was reported that liquids were dumped into a "drain hole" near the southeast corner of the building. This "drain hole" may well have been one of the clean-out pipes for either Seepage Pit No. 7A or 7B.

Construction details on both of the referenced drawings indicate that the seepage pits were constructed of unmortared brick, measured 5 feet in diameter, and were to have minimum depths of 20 feet below finished surface grade. Four-inch-diameter cast iron pipe was used to carry wastes outside of the building's footprint before joining a 6-inch-diameter vitrified clay pipe that discharged into Pit No. 7. Both 4-inch-diameter cast iron and vitrified clay pipe were used to tie Pit No. 7 with Pit Nos. 7A and 7B.

Seepage Pit Nos. 8 (Dry Well), 13, and 13A

Seepage Pit Nos. 8, 13 and 13A were all connected to former Buildings 65's interior plumbing. Former Building 65 was used as a materials laboratory that housed two chemistry labs and a chemical-storage area, X-ray and metallurgy lab with a dark room, microscope room, a physics laboratory equipped with a universal testing machine, offices, and a library. Seepage Pit Nos. 8 (dry well), 13, and 13A served former Building 65 in three different ways. Seepage Pit No. 8 was actually a 3-foot-square by 3-foot-deep concrete dry well to collect liquids originating from a pit in the floor where a universal testing machine was located, Seepage Pit No. 13 collected liquid waste from the north side of the building where chemistry laboratory rooms with counter-top and floor sinks were located, and Seepage Pit 13A collected sanitary wastes from the restrooms located on the south side of the building. Locations of the two seepage pits and dry well with respect to Building 65 are shown on JPL Drawing Nos. 65/2-3 and 65/44-0. A fourth seepage pit location on the east side of Building 65 was indicated on Drawing JPL0901A-0 but could not be found on the actual construction drawings. Since this seepage pit would also be located under Building 302, soil-vapor samples collected near the foundation on each side of the building should detect any VOC contamination from the fourth seepage pit if the pit is, in fact, present.

Seepage Pit No. 13 was investigated by Richard C. Slade (Slade, 1984) using a backhoe to obtain soil samples for analysis (see Section 5.1.4) following the buildings' demolition. The only significant finding in Slade's study of this seepage pit was an elevated level of lead with a concentration of 200 mg/kg in an undisturbed soil sample from a depth of 7 feet.

Based on the information presented on the construction drawings, 2-inch-diameter cast iron pipe connected the testing-machine pit to the dry well and was also used to drain the chem-lab sinks to Seepage Pit No. 13. Information on the depth of the pit is not available.

A combination of 4-inch-diameter cast iron and vitrified clay pipe was used to carry sanitary wastes from the restrooms to Seepage Pit No. 13A. The cast iron pipe extends only 3 feet outside of the building's footprint before connecting with the vitrified clay pipe. Information on the depth of the pit is not available.

The locations of the two seepage pits and dry well now lie within the footprint of Building 302, the Microdevices Laboratory, which is a two-story structure with a deep basement. To construct the foundations and bottom floor for Building 302, 18 to 21 feet of soil had to be excavated from the building's west side. Since the building site sloped to the east, only about 6 to 8 feet of material were required to be removed from that side of the construction area. There is no documentation in available files on the removal of seepage pits during the excavation operations.

Seepage Pit No. 9

The origin and purpose for Seepage Pit No. 9 is not well documented. It is not known if the pit was originally connected to former Building 44 (the old credit union building), or earlier portions of former Building 13 that housed offices and a small workshop. It is indicated on JPL Drawing No. 13/14-1 that Building 13 was constructed over the seepage pit with the notation "approximate location existing cesspool to be filled after service is discontinued" shown on the drawing. On Drawing No. JPL0901A-0, a cesspool and connection piping is shown to be connected to Building 44, but the seepage pit is located southwest of Building 13. No other records on this seepage pit could be found in available records. However, in either case, the seepage pit locations are well within the footprint of existing Building 302.

Seepage Pit No. 10

Seepage Pit No. 10 was located approximately 15 feet from the northwest corner of Building 78 and is believed to be covered presently by a concrete retaining wall and a bank of horizontally stacked nitrogen gas tanks. The pit's approximate location is shown on JPL Drawing Nos. 78/2-0 and 78/37-0. Drain lines from a lavatory sink and a water closet were connected to the seepage pit via a section of 4-inch-diameter cast iron pipe and an extension of 6-inch-diameter vitrified clay pipe. Lengths of these sections are not shown on the drawings. Construction details for the seepage pit are not available.

Building 78 was first designed and used for housing large hydraulic testing machines. This building is referred to as the Hydraulics Laboratory even though the testing machinery was removed a number of years ago. A number of smaller laboratories were housed in this building during its history and included a small laser laboratory, a ceramics room, the "Ocean's Lab," and a cryogenic sensor technology laboratory. Today, one half of the building is occupied by the Space Cryogenics Laboratory and the other half by JPL's glassblowing shop.

Since solvents are often used to clean machinery and degrease parts, the likelihood of solvents being used in the hydraulics laboratory is high.

Seepage Pit No. 11

This seepage pit was used to collect sanitary wastes from former Buildings 101 (Transportation Offices) and 104 (First Aid Building) and was located approximately 40 feet downslope to the southeast as indicated on Drawing JPL0901A-0. Both of these buildings housed restrooms, but interior piping information is not available. Exterior piping, as shown on the referenced drawing, consisted of 4-inch-diameter vitrified clay.

Based on the historical use of these buildings, it is unlikely that interior drains were used to dispose liquid chemicals or solvents.

Seepage Pit No. 12

This seepage pit was located approximately 15 feet northwest of former Chemical Test Cell Building (Building 74) adjacent to existing Building 78's southwest side. Construction details for the seepage pit are shown on JPL Drawing No. 74/23-0.

Building 74 was constructed for testing chemical and liquid propellants, and solvents were used for cleaning and degreasing equipment and hardware. Although only a small sink in this building was connected to the seepage pit via 5 feet of 2-inch-diameter cast iron pipe and 10 feet of 4-inch-diameter vitrified clay pipe, the clean-out for the seepage pit was located just outside of a later-constructed entrance to Building 78 and accessible for dumping chemicals or solvents directly into the pit. It was reported that spent chemicals were poured into the sink on several occasions. Seepage Pit No. 12 was constructed of unmortared brick and had an inside diameter of 4 feet.

Seepage Pit Nos. 13 and 13A
(See Seepage Pit No. 8)

Seepage Pit No. 14

Seepage Pit No. 14 was located approximately 20 feet northwest of former Building 46, a workshop building that supported an adjacent liquid propellant test cell (Test Cell "G") housed in Building 42. The location of this seepage pit is shown on JPL Drawing Nos. 42/2-0 and JPL0901A-0.

Solvents were reportedly used to clean the propellent testing devices, hardware, and exhaust areas following the actual tests. The solvents were commonly stored in the shop building. Small spills occurred frequently.

Sanitary wastes from the restroom were carried through a 4-inch-diameter cast iron pipe to a point at least 3 feet outside the building where this pipe connected to a 6-inch-diameter vitrified clay pipe that drained to the seepage pit. A 2-inch-diameter cast iron pipe connected the sink drain to the 4-inch cast iron pipe outside the building.

Construction details for the seepage pit are not available, but it is assumed that it was of similar construction (unmortared brick) to others located in the area.

The site of former Building 46 now lies within the footprint of existing Building 302, and the seepage pit is believed to be near the sidewalk under the elevated porch leading to the building's main entrance.

Seepage Pit No. 15

According to JPL Drawing No. 33/2-2, Seepage Pit No. 15 was located approximately 38 feet northwest of former shop Building 34 that was demolished prior to constructing Building 300. The old seepage pit location is believed to be adjacent to or under the foundations for Building 300.

This seepage pit collected liquid wastes from a small counter-top sink in Building 34, which served as a work shop area associated with former test-cell Building 33 (Test Cell "F") where various types of liquid propellants were test fired. Solvents and other cleaning agents used in the liquid propellent test cell to clean equipment and hardware may have been stored in Building 34. Small chemical spills reportedly occurred in the test cell over a period of several years.

Materials used in constructing the seepage pit are not shown on the drawings, but it is believed that unmortared bricks were used since these materials were found at other nearby seepage pit locations (Seepage Pit Nos. 13 and 16). Dimensions of Seepage Pit No. 15 are also not available. The drain line connecting the sink to the seepage pit was constructed with 4-inch-diameter vitrified clay pipe.

Seepage Pit No. 16

Located approximately 17 to 18 feet southwest of former Building 59, this seepage pit was constructed to receive liquid wastes from a sink inside the building, which originally housed a paint shop and spray booth. Building 59 was later converted to a chemistry laboratory.

Seepage Pit No. 16 was investigated by Richard C. Slade using a backhoe for excavating exploration trenches to locate the seepage pit and obtain soil samples for chemical analyses (see Section 5.1.4 in the RI/FS Work Plan). Slade located the pit, which was constructed of unmortared brick, and obtained undisturbed and bulk samples within the upper 8 feet of soil. Results of the chemical analyses conducted revealed no significant findings.

Construction details of the piping (shown on JPL Drawing 59/1-0) indicate that 2-inch- and 4-inch-diameter cast iron pipe were used to connect the sink to the seepage pit. Also, based on the available information, the seepage pit location is near the northern end of the elevated patio railing along the east side of present Building 303. Building 59 would have been located partly in the area occupied by Building 303's patio and partly in the parking lot on the building's north side.

Seepage Pit No. 17

As shown on Drawing No. JPL0910A-0, this seepage pit was located 60 to 65 feet from former Building 55, which was a solid propellant mixing facility. Construction drawings of the building's interior are not available, but it is assumed that the building housed facilities similar to those in other buildings where solid propellants were prepared. Hence, sinks and tubs for soaking and cleaning the mixing equipment were probably present in Building 55.

Solvents (e.g., carbon tetrachloride, methyl ethyl ketone, trichloroethene, and cyclohexanone) were routinely used to clean the mixing hardware and reportedly disposed, on occasion, by pouring into the sinks and tubs before connections to the sewer system were completed.

A 6-inch-diameter vitrified clay pipe connected the building's drain pipes to the seepage pit. Based on the size of the clay piping, Building 55 probably housed restroom facilities in addition to cleaning sinks.

The area previously occupied by Building 55 is presently a parking area for NASA trucks and buses located near Building 280.

Seepage Pit Nos. 18 and 19

These two seepage pits are connected in tandem to currently existing Building 90 with 4-inch-diameter cast iron pipe and are situated west and southwest of the building (JPL Drawing Nos. 77/25-0 and 90/9-0). Building 90 served as an observation and shop facility for a former solid propellant test cell (Building 51 that was referred to as Test Cell "X") and housed restroom facilities and sinks.

It was reported that test motors and other hardware were cleaned by soaking in tubs of solvents (including acetone and carbon tetrachloride) that were not recycled and allegedly dumped into sumps (Seepage Pit Nos. 18 and 19) on the west side of Building 90 or at the east end of the solid propellant preparation area.

Details on the seepage pits are not available, but they are assumed to be constructed with unmortared bricks since these materials were used in seepage pits at other buildings constructed during the same time frame.

Seepage Pit Nos. 20 and 21

Former Buildings 58 and 63 were joined together and, in combination, housed large compressors, maintenance shops for the compressors and other machinery. By 1960, the combined structure was referred to as Compressor Building 58. Seepage Pit No. 20 was connected to the original Building 63 by approximately 40 feet of 4-inch-diameter cast iron pipe with a 60-foot extension of 6-inch-diameter vitrified clay pipe. The locations of Seepage Pit 20 and the pipeline are shown on Drawing JPL0902A-1. Following the merger of designations for Buildings 58 and 63, a second seepage pit (Seepage Pit No. 21) was constructed about 16 feet east-southeast of Pit No. 20 (JPL Drawing No. 77/25-0). Information on the type and size of the pipe connecting the two seepage pits is unavailable.

Neither construction drawings nor interior plans for Building 63 are in the available files, so the interior draining system (including restrooms, sinks, floor drains) is not known.

Solvents are routinely used to clean parts and machinery, and are commonly stored where they are used.

Former Building 58 has been demolished and the two seepage pit locations are covered by a filled and graded parking lot. In addition, the location of Seepage Pit No. 21 may underlie the foundation for the retaining wall on the south edge of the parking lot adjacent to the north side of Aero Road.

Seepage Pit No. 22

The location of Seepage Pit No. 22, as shown on JPL Drawing No. 77/25-0, is near former Building 80 that housed a wind tunnel. Construction details for the seepage pit, piping, and Building 80 are not in the files.

Based on information available, there were no reports of solvents or chemicals being used in this building.

The area formerly occupied by Building 80 is presently an asphalt-paved parking lot north of existing Building 79, and the parking lot is covered by office trailers. The seepage pit location is beneath the office trailers.

Seepage Pit Nos. 23, 24, and 25

Locations of these three seepage pits are shown on Drawing No. JPL0902A-0. They served existing Building 67 by collecting liquid and sanitary wastes from a diverse number of small laboratories and four restrooms. Although primarily an office building, small laboratories and research rooms (e.g., biology, kinetics, low-level radioactive, magnetics, computer development, range correction, spectroscopy, etc.), as well as storage rooms for finished components and parts, were housed in Building 67 during its history of occupancy. Several of these laboratory rooms existed prior to connecting with the sewer system.

There are no records for the types and amounts of chemicals used in this building and their usage was unknown to interviewees. Also, construction details for the seepage pits are not available. As indicated on Drawing JPL0902A-0, 6-inch-diameter vitrified clay pipe was used to convey the liquid and sanitary wastes to the seepage pits from the interior 4-inch-diameter cast iron plumbing lines. Seepage Pit Nos. 23 and 24 are beneath the asphalt-paved parking area along Explorer Road south of the building's central section, and Seepage Pit No. 25 is beneath a walkway or landscaping near the west end of the building on its south side.

Seepage Pit No. 26 and 28

Seepage Pit No. 28 has been referred to as a "dilution tank" (JPL Drawing No. 77/1-0), an "acid sump" (JPL Drawing No. 77/2-0), a "fluorine pit" (JPL Drawing No. 77/4-1), and a "cesspool" (JPL Drawing No. 77/21-1). In actuality, the pit was originally designed and constructed to receive exhaust gases from a fluorine propellant test cell located in former Building 77. A 23-foot-long steel pipe having an inside diameter of 18 inches sloped downward from the test cell, at an angle of 30 degrees, to the pit that was situated on the building's north side. Notations on JPL Drawing No. 77/2-0 called for the pit shaft to be constructed 4-foot square with "walls to be of suitable material" to a depth of 15 feet, plus or minus, with a 2-foot-thickness of crushed limestone at the bottom. It is indicated on JPL Drawing No. 77/1-0 that the shaft was 5 feet in diameter and 20 feet deep. Floor drains located in two of the building's rooms were connected to the shaft by 2-inch- and 4-inch-diameter cast iron pipes.

Building 77 also housed an experimental chemistry laboratory and various chemicals may have been dumped into the exhaust shaft (Seepage Pit No. 28). The crushed limestone was placed at the bottom of the shaft to neutralize fluoric acid produced during experimentations with fluorine propellants. Interviewees reported that numerous chemicals were disposed by dumping into available "sumps" near the building.

Seepage Pit No. 26 was located on the south side of Building 77 and received both liquid and sanitary wastes from, respectively, sinks and a restroom. Exterior piping consisted of 4-inch-diameter vitrified clay (JPL Drawing No. 77/33-0). Construction details for this seepage pit and the building's interior plumbing are not available.

Most of the area formerly occupied by Building 77, including Seepage Pit No. 28, is now covered by existing Building 299. However, the location of Seepage Pit No. 26 is believed to be in Pioneer Road near the west end of Building 299 (JPL Drawing No. 299C010A0-0). It should be noted that both of these seepage pits are located upgradient from monitoring well MW-7.

Seepage Pit No. 27 (Dry Well)

Seepage Pit No. 27 is a dry well constructed of precast reinforced concrete pipe sections topped with a standard concentric cone section of similar materials. The pit receives liquid wastes (created when researchers wash common soil from their hands) through a 2-inch-diameter cast iron pipe from two small counter-top sinks located in Soils Laboratory Building 246. These construction details, as well as the dry well's location, are shown on JPL Drawing No. 246/3-10.

Primary activities at Building 246 involved experimentation with soil conditioning and various types of vegetation to evaluate the most effective methods for revegetating slopes and controlling erosion. There is no history or knowledge of solvents or petroleum products having been used at this location.

Seepage Pit No. 29

According to JPL Drawing No. 32/1-0, Seepage Pit No. 29 was located between former Buildings 32 and 20 in the liquid propellant testing area. Building 32 housed the test cell where solid propellants were fired during the late 1940s and liquid propellants during the mid-1950s. Building 20 was the shop used to provide support for the test cell in Building 32.

The seepage pit was designed for collecting liquids from two floor drains located in the test cell. Each drain was located near the center of sloped gutters along opposing walls in the test cell's firing bay. The drains were connected to the seepage pit by 4-inch-diameter vitrified clay pipe. It is noted on the referenced construction drawing that the seepage pit was to have a 4-foot inside diameter and extend to a depth of 16 feet with no overflow. Construction materials were not specified. Unmortared bricks were probably used to construct the pit's shell since some red bricks were excavated from that location when Buildings 20 and 32 were demolished and the area regraded for constructing a parking lot.

Solvents were commonly used to clean the propellant testing motors and associated hardware. It has been reported that solvents, degreasers, and chemical cleaners were applied with rags, paint brushes, or spray bottles and then wiped-down by hand or hosed-off with water.

Solvents commonly used during the early years included carbon tetrachloride, methyl ethyl ketone, and acetone.

Seepage Pit No. 30

Existing Building 117 formerly housed a solid propellant test cell and a seepage pit was located approximately 7 to 8 feet from the south wall near the southwest corner of the building (JPL Drawing Nos. 117/50-0 and 117/50-4). A small counter-top sink was located inside the building opposite the seepage pit location. Restrooms were not housed in the building. Construction details are not available for either the seepage pit or the piping connections.

Solvents were commonly used to clean rocket motors and hardware, and these solvents reportedly were not recycled, but were disposed of by dumping into nearby sumps and drains.

Seepage Pit No. 31

As shown in location and grading plan details on JPL Drawing No. 107/69-0, Seepage Pit No. 31 is located about 9 feet due south of Building 112's (now Building 107) southwest corner almost directly between Building 112 and former Building 12. Piping diagrams are not shown on this drawing and there is a possibility that the seepage pit was connected to both buildings. Restroom facilities were not located in Building 112 and records for Building 12 are not available.

At one time, Building 112 housed two liquid propellant test cells. In the early 1960s, this building merged with Building 107 (also a test cell for liquid propellants), and the combined structure is presently referred to as Building 107. This combined structure later housed plasma flow and laser research laboratories, and it is currently associated with laser and robotics development.

Solvents were used routinely in the liquid propellant test cells for cleaning and degreasing experimental firing equipment and hardware. Spills commonly occurred, but were reportedly small.

The purpose for Seepage Pit No. 31 is not clear, and construction details (other than location) regarding it's size, depth, and composition are not available.

Seepage Pit No. 32

This seepage pit is located on the south side of existing Building 86 and apparently collected liquid wastes from existing Buildings 98, 87, and, possibly, 88. The pit's location is shown on JPL Drawing No. 98/1-0, which includes piping details on drains coming from Building 98 (containing five floor drains), and lead-in drains originating at Buildings 86 and 87. Exterior piping is indicated as both 4-inch-diameter vitrified clay and cast iron, while interior piping consists of 2-inch-, 3-inch-, and 4-inch-diameter cast iron.

A plumbing diagram on JPL Drawing No. 88/1-0 shows a 4-inch-diameter vitrified clay pipe leading away from the building. The drawing detail notes "4 (in.) VC to dry well, see plot plan." However, the plot plan could not be found in available records. This line could run to Seepage Pit No. 32, or it could lead to another unidentified pit west of Building 86. In fact, the plumbing diagram on JPL Drawing No. 86/7-3 does not show a seepage pit at the location indicated on Drawing 98/1-0, but does show an exterior 3-inch-diameter cast iron pipe leading westward from the inferred seepage pit location at Building 86 with the notation "3 (in.) CI soil pipe to cesspool, see plot plan."

Buildings 86, 87, 88, and 98 are all located at the east end of the solid propellant preparation area where numerous types of solvents were used to clean mixing equipment and hardware.

No other construction details on Seepage Pit 32 are available.

Seepage Pit No. 33

According to the plumbing details shown on JPL Drawing No. 97/1-0, Seepage Pit No. 33 is located 16 feet from the west end of existing Building 97 and collected liquid wastes from 4 counter-top sinks, two floor drains, and a series of unidentified wall-mounted inlets. Two- and 4-inch-diameter cast iron pipe was used inside the building and connected to an exterior 4-inch-diameter vitrified clay pipe leading to the seepage pit.

Restroom facilities, located on the north side of Building 97 near its east end, are shown on Drawing No. 97/1-0 to be connected to an unidentified pipe exiting the building, but no indication is given as to it's destination. No other information is available on piping, connections, or construction of the seepage pit.

Building 97 was a development laboratory for solid propellant chemistry experimentation and numerous solvents were used to clean laboratory hardware, including acetone, carbon tetrachloride, methyl ethyl ketone, and trichloroethene. During the employee interviews, it was reported that sumps in the vicinity of Building 97 were used to dispose spent solvents.

Seepage Pit No. 34

On JPL Drawing No. 98/2-1, Seepage Pit No. 34 is noted as a 20-feet-deep dry well located about 9 feet north of the east end of existing Building 98. A floor drain in a small exterior storage area was connected to the dry well by 4-inch-diameter cast iron pipe. This building was originally designated as "Cleaning and Spray Building" and housed a larger "cleaner room" with a floor that sloped to a drain in the center of the floor. A 4-inch-diameter interior cast iron pipe and 4-inch-diameter vitrified clay pipe connected this drain to Seepage Pit No. 32 located on the south side of Building 86 as shown on JPL Drawing Nos. 98/1-0 and 98/7-0. A roofed solvent-storage area underlain by a concrete slab is shown on the drawing to be adjacent to the dry well.

Building 98 was later (early to mid 1950s) converted to a solid propellant preparation shop. Solvents were used to clean mixtures of propellant chemicals and binders from mixing equipment and related hardware. Reportedly, a pit at the east end of the solid propellant preparation area in the vicinity of Building 98 was used for disposal of carbon tetrachloride, methyl ethyl ketone, trichloroethene, and other chemicals after the sewer system was installed.

Seepage Pit No. 35

This seepage pit received liquid and sanitary wastes from former Building 81 that housed offices, workshops, storage rooms, and restrooms. The seepage pit was located approximately 35 feet in a southeasterly direction from the building's western end according to plot-plan details on JPL Drawing Nos. 81/3-2 and 81/43-0. Sanitary wastes were conveyed from the east end of the building through a 4-inch-diameter vitrified clay pipe that joined with a 6-inch-diameter vitrified clay pipe from the building's west end just before connecting with the seepage pit.

Construction details for the seepage pit are not available, but it is assumed that it would be similar to others nearby that are constructed with unmortared brick. Also, it is indicated on the referenced drawings that this seepage pit was also connected to Seepage Pit Nos. 1 and 2.

Seepage Pit No. 36

This seepage pit was discovered during the removal of a large, storm drain catch basin that was constructed directly over the top of the pit. The location of this pit is not shown on any plans or drawings in available files, so it cannot be determined which building was connected to Seepage Pit No. 36. However, because it was located approximately 20 to 25 feet in front of Building 107, it may have been connected to this building at one time. Construction workers reported that the pit was 4 to 5 feet in diameter and constructed with unmortared red bricks.

Soil sludge in the demolished catch basin was reported to contain elevated concentrations of carbon tetrachloride, acetone, trichloroethene, methyl ethyl ketone, tetrachloroethene, styrene, and mercury. Detailed information is presented in Section 5.1.10 of the RI/FS Work Plan.

Seepage Pit No. 37 (Dry Well)

As noted on Drawing No. JPL0901A-0, this seepage pit was described as a dry well and was connected to Building 2 that housed an inspection and gage laboratory. The purpose for the dry well, as well as details on its construction piping, and size are not available.

The final number of seepage pits identified during this effort was 40 since Seepage Pit Nos. 7A, 7B, and 13A are included in the total count.

Waste Pit No. 1

Waste Pit No. 1 (WP-1 in Figure 4-1) was not an actual pit as such, but was an open area where wastes may have been conveniently disposed. This area could have been a channel or gully caused by erosion at the location where a 36-inch-diameter storm drain empties into the Arroyo Seco near the south end of Building 103. It was reported during the interviews that small amounts of spent solvents, mercury, and other wastes were intermittently dumped in this area.

Waste Pit No. 2

During the late 1940s and early 1950s, a large shallow depression (WP-2) was bulldozed in the Arroyo Seco at the approximate location shown in Figure 4-1. This depression was reportedly used primarily for the disposal of glass and metal shavings, and can be seen in aerial photograph Nos. JB931C and JB931H contained in the JPL Photo Library. Both of these photographs are also presented as Figures 5-12 and 5-14, respectively, in the RI/FS Work Plan.

Waste Pit No. 3

A former salvage storage area located just southeast of existing Building 248 was reportedly used for the disposal of solvents. The storage area was mistakenly reported, during an interview, as being in the vicinity of existing Building 144, which is located west of Building 248. However, the alleged disposal area is located about 300 feet east of Building 144. This area is shown in Figure 4-1 and is designated as WP-3. Approximately three 55-gallon drums of diluted solvents were allegedly dumped into two or three hand-dug holes every 3 to 4 months over a period of 2 to 3 years during the late 1950s. The holes were approximately 25 feet apart, about 4 feet wide by 3 feet deep, and were located east of former Building 119 that was identified in aerial photograph No. JB 1673B from the JPL Photo Library (see Figure 5-15, Section 5.1.11 in the RI/FS Work Plan). These disposal holes are not shown on any of the available construction drawings in the Facilities Engineering Office.

It was reported that, most likely, the solvents disposed were from cleaning parts and would have been a mixture of trichloroethene, acetone, M50 (trichloroethane), alcohol, and toluene. It was believed that carbon tetrachloride was not in use at JPL during the period of time that the salvage yard was in this area. These disposal holes may be very critical in the evaluation of contaminant sources since they are located upgradient from monitoring well MW-7.

Building 306 Area

During the excavation for the Optical Instruments Laboratory's (Building 306) foundations and bottom floor, soils contaminated with petroleum hydrocarbons were encountered. Other debris (shrubs, railroad ties, broken concrete, tree stumps, piping, etc.) was also encountered while removing the contaminated soils. Since the source of contamination and debris was unknown, soil samples collected from hollow-stem auger borings were analyzed for TRPH (EPA Method 418.1), volatile and semi-volatile organics (EPA Methods 8240 and 8270, respectively), PBCs and pesticides (EPA Method 8080A), aromatic volatiles (EPA Method 8020), diesel (EPA Method 8015 modified), metals, and cyanide. Results of the analyses indicated that only TRPH and diesel fuel were present in the soils at elevated concentrations. Volatile and semi-volatile organics, pesticides, PCBs, and cyanide were not detected; metals were present at low concentrations (see Table 5-18 in Section 5.1.13 of the RI/FS Work Plan).

Excavation and removal of the contaminated soils continued over a 3-month period, and approximately 19,000 tons of non-hazardous contaminated soil were removed. Confirmation sampling, analyses, and excavation continued until TRPH concentration within the building's footprint were non-detectable. It was decided that soil with minimum levels of TRPH (50 mg/kg or less) would be left in place and capped with an asphalt parking lot.

4.2 SOIL VAPOR SAMPLING LOCATIONS

Forty subsurface seepage pits or dry wells, three surface or open areas reportedly used for disposing liquid wastes, and another area of concern where elevated concentrations of TRPH were detected previously, have been identified as potential source locations during the review of JPL facility records and interviews with current and former employees. These locations are listed in Table 4-1.

Also indicated in Table 4-1 is whether or not underground utilities have been cleared at the potential source location. All sampling locations will be cleared for underground utility lines using standard electromagnetic and ground penetrating radar methods prior to any subsurface explorations. Locations cleared for soil-vapor probing and soil-boring drilling will be marked with green paint.

A mobile soil-vapor sampling van will be used to collect one initial soil-vapor sample at each accessible location from a depth of 20 feet, or shallower if refusal occurs. Attempts will be made to locate the mobil sampling van as close to the potential source location as possible on its downgradient, or downslope, side. If the potential source location cannot be accessed by the mobile sampling van, then the sampling probe tip will be driven into the subsurface manually with a sliding hammer-drive apparatus or by using either a pneumatically or hydraulically driven jack hammer.

Two seepage pits (Nos. 22 and 27) have been eliminated from the exploration program because there was no evidence of solvent or chemical usage associated with their history. Of the eleven seepage pit locations that are inaccessible to a mobile soil-vapor sampling van or drilling equipment because of terrain or by being located under existing structures, seven of them (Nos. 4, 9, 10, 11, 25, 28, and 32) will be sampled for soil-vapor by manual methods. Soil-vapor samples will be collected as close as possible to the remaining four inaccessible seepage pit and dry well locations (Nos. 7, 8, 13, and 13A) by installing soil-vapor probes along the sides of the buildings nearest the pits. The sampling probe tip and tubing installed at each sampling location will be left in place so that additional soil-vapor samples may be collected in the future if needed. Details on the sampling procedures, equipment, and collection are discussed in Section 6.1.

TABLE 4-1

RATIONALE FOR SOIL VAPOR SAMPLING LOCATIONS

Seepage or Waste Pit No.	Associated Building No.	Building Still Exists (Yes/No)	Utilities Cleared (Yes/No)	Influencing Factors
Sampling Locations:				
1 & 2	3, 4, 17, 19, 22	No No	Yes	Pits connected in tandem and located in area having oldest use-history on JPL site; recent discovery of solvents and other contaminants in nearby seepage pit that was uncovered during ongoing construction work.
3	11	Yes	Yes	Building 11 housed plumbing and electrical shops where solvents may have been used.
4	11	Yes	No	Pit connected in tandem with Seepage Pit No. 3. Seepage pit located under steep slope north of Building 11; inaccessible to soil vapor sampling van or drill rig, but accessible for manual soil vapor sampling.
5	68, 71, 127	No	Yes	Original use of Building 127 is not known; Building 68 once housed electrical and plumbing shops and Building 71 was used as "mechanical stores." Buildings are located near old solid propellant bunkers and may have been used to store solvents used in mixing and developing propellants.
6	Unknown	NA	Yes	Drilling and sampling proposed because implications are similar to those for Seepage Pit Nos. 1, 3 and 5.
7, 7A & 7B	103	Yes	No	Seepage pits connected in tandem; building housed machine shop fabrication shop, and metal pickling room; solvents used for cleaning and degreasing; alleged dumping of liquids in "drain hole" near southeast corner of building. Soils downgradient from seepage pits can be investigated with two soil-vapor probes.
8 (DW)	65	No	No	Dry well, now under Building 302, from pit where universal testing machine was located; inaccessible to soil-vapor sampling, but two soil-vapor probes proposed along southeast side of Building 302 and proposed downgradient monitoring well MW-12 is nearby.
9	13 or 44	No	No	Pit is under Building's 302 shed area and true location is questionable. It may have been connected to Building 13, which housed a small workshop, or the old Credit Union Building 44. Location inaccessible to soil vapor sampling van or drill rig, but accessible for manual soil vapor sampling and proposed downgradient monitoring well MW-12 is nearby.
10	78	Yes	No	Building 78 housed a hydraulic laboratory; solvents commonly used to clean machinery and degrease parts. Seepage pit located under retaining-wall foundation and bank of horizontally stacked tanks of nitrogen gas; inaccessible to soil vapor sampling van or drill rig, but accessible for manual soil vapor sampling.

RATIONALE FOR SOIL VAPOR SAMPLING LOCATIONS

Seepage or Waste Pit No.	Associated Building No.	Building Still Exists (Yes/No)	Utilities Cleared (Yes/No)	Influencing Factors
11	101 & 104	No	No	At base of slope near retaining wall on north side of Building 113; inaccessible to soil vapor sampling van or drill rig, but small area at west end of building accessible for manual soil vapor sampling.
12	74	No	Yes	Chemistry test cell (liquid propellants); solvents reportedly used for cleaning and degreasing; disposal of chemicals reported to have occurred by pouring into drains.
13 & 13A	65	No	No	Seepage pits, located under Building 302, from old materials laboratory; may have housed machinery and metals cleaned with solvents; also housed chemistry laboratory. Inaccessible to soil vapor sampling van or drill rig, but two soil-vapor probes proposed along southeast side of Building 302 and proposed downgradient monitoring well MW-12 is nearby.
14	46	No	No	Shop for liquid propellant test cell; implications are same as those for Seepage Pit No. 12 and 15.
15	34	No	No	Shop building associated with old test cell buildings (Test Cell "F") and liquid testing facility; spilled solvents reportedly small, but did occur on regular basis over several years.
16	59	No	No	Building housed old paint shop.
17	55	No	Yes	Solid propellant mixing facility; solvents used to clean mixing hardware were disposed by pouring into sumps prior to installation of sanitary sewer system.
18 & 19	90	Yes	No	Shop for test cell No. 51 (solid propellant testing in Test Cell "X"); large test motors and hardware soaked in tubs of solvents (included carbon tetrachloride and acetone) that were not recycled and allegedly dumped into sumps on west side of Building 90 or at east end of solid propellant preparation area (East of Building 88).
20 & 21	63	No	Yes	Pits connected in tandem. Compressors and maintenance shop; solvents routinely used for parts cleaning. Soils downgradient from seepage pits could be sampled with single boring.
23 & 24	67	Yes	Yes	Seepage pits connected in tandem about 15 feet apart. Building's history is diverse. Although mainly an office building, several small laboratories (biology, kinetics, low-level radioactive, and spectroscopy) were located within the structure over a several-year period--possibly before connections made to sanitary sewer system. Since these pits are only about 15 feet apart, one soil vapor sampling probe and one soil boring well address both pits.

RATIONALE FOR SOIL VAPOR SAMPLING LOCATIONS

Seepage or Waste Pit No.	Associated Building No.	Building Still Exists (Yes/No)	Utilities Cleared (Yes/No)	Influencing Factors
25	67	Yes	No	Implications are same as those for Seepage Pit No. 23. Seepage pit located in walkway area between top of slope and south wall of Building 67; inaccessible to soil vapor sampling van or drill rig, but accessible for manual soil vapor sampling.
26	77	No	Yes	Structure housed experimental chemistry lab and fluorine propellant test cell with an acid-neutralizing pit constructed similar to a dry well, numerous chemicals reportedly disposed by dumping into available sumps near building. Seepage pit is upgradient from monitoring well MW-7.
28	77	No	No	"Acid Pit" for Building 77; now under Building 299; inaccessible to drill rig, but accessible for manual soil vapor sampling and possibly for mobil sampling van.
29	32	No	Yes	Test cell used for liquid propellant testing since mid-1950s; solid propellants used during late 1940s. Seepage pit located near area where ongoing construction work disclosed solvent contamination in storm-drain catch basin and previously unknown seepage pit.
30	117	Yes	Yes	Building housed former solid propellant test cell where solvents used to clean rocket motors and hardware; solvents reportedly not recycled and disposed of by dumping into nearby drains and sumps.
31	12 107, 112	No Yes	Yes	Both buildings contained propellant test cells; solid propellants may have been used during early history of buildings, along with solvents associated with solid propellant clean up. Building 107 later converted to plasma flow research laboratory.
32	86	Yes	No	Seepage pit near east end of solid propellant preparation area and adjacent to Building 86; pits (sumps) in area reportedly used to dispose of solvents. Seepage pit located in small flat area between top of steep slope and south wall of Building 86; inaccessible to soil vapor sampling van or drill rig, but accessible for manual soil vapor sampling.
33	97	Yes	Yes	Development laboratory for solid propellant chemistry experimentation; solvents used to clean laboratory hardware; all sink drains led to seepage pit; a sump or dry well at west end of building reportedly used for solvent disposal.
34	98	Yes	Yes	Seepage pit at east end of solid propellant preparation area (Buildings 86, 87, 88, 89 and 98); pit reportedly used for disposal of carbon tetrachloride, methyl ethyl ketone, trichloroethene, and other chemicals after sewer system installed.

RATIONALE FOR SOIL VAPOR SAMPLING LOCATIONS

Seepage or Waste Pit No.	Associated Building No.	Building Still Exists (Yes/No)	Utilities Cleared (Yes/No)	Influencing Factors
35	81	No	Yes	Building housed workshops, storage rooms, and offices. Seepage pit located in same area where solvents and other chemicals discovered in soil during ongoing construction. (See rationale for boring reference Seepage Pit Nos. 31 and 36.)
36	Unknown	NA	No	Storm drain catch basins removed during ongoing construction were contaminated with carbon tetrachloride, acetone, chloroform, trichloroethene, and mercury; sump tanks (leakages reported), dilution chambers, and seepage pits, associated with test cells and shops, existed along north side of Jato Road).
37 (DW)	2	No	Yes	Dry well for drain from building has unknown use, but implications are same as those for Seepage Pit Nos. 1, 2, 7A, 7B, 31, and 35.
WP-1	None	NA	No	Erosion gully where solvents and mercury(?) reportedly dumped.
WP-2	None	NA	No	Shallow depression bulldozed in Arroyo Seco where glass and metal shavings were disposed.
WP-3	119	No	No	Solvents at varying concentrations reportedly dumped in hand-dug holes over a period of 2 to 3 years.
NA	197	Yes	Yes	1,000-gallon tank (possible leakage) located at west end of building; propellant grindings and solvents reportedly dumped into tank at frequent intervals.
Bldg. 306	306	Yes	No	Approximately 19,000 tons of soil contaminated with petroleum hydrocarbons removed from excavation for building's foundations and first floor.
SEEPAGE PITS ELIMINATED:				
22	80	No	No	Wind tunnel building; no history of solvent or chemical usage.
27 (DW)	246	Yes	No	Dry well from sink at former soils test laboratory; no history of solvent or chemical usage.

NA - Not Applicable
DW - Dry Well

All soil-vapor samples collected will be analyzed for VOCs in accordance with the California Regional Water Quality Control Board, Los Angeles Region's (RWQCB's) guidelines that are presented in Appendix A.

4.3 STEP OUT SOIL-VAPOR PROBES

At potential contaminant source areas where the initial soil-vapor sample has a total VOC concentration of 1.0 milligram per liter (mg/l) or more, a minimum of three additional soil-vapor samples will be collected and analyzed. Step-out locations will be located initially in a triangular configuration centered over the first probe location. Each step-out location will be within 10 to 20 feet from the first probe or the previous step-out location that had elevated VOC levels. In areas where surrounding structures or buried utilities do not permit such a configuration, the sampling configuration will be altered based on acceptable field conditions. At each new sampling location, the sampling procedure used during the initial soil-vapor survey will be used. All probes and tubing will be left in place to allow for the collection of additional samples if needed.

4.4 NESTED SOIL VAPOR MONITORING WELLS

Nested soil-vapor monitoring wells, designed to investigate the vadose zone, will be installed at two locations with the highest total VOC concentrations as determined by the shallow soil-vapor surveys as a pilot study for the need and applicability of nested soil-vapor wells at the JPL site. Each nested well will be located in the area of highest detected VOC concentrations unless access or underground obstructions do not permit. In such situations, the nested wells will be located as close as possible to the area of highest concentrations. Each nested well will be installed to 100 feet below the ground surface or to the top of the groundwater table, whichever is shallower. The average proposed depth was based on historical data on the depths to groundwater and the fluctuation of groundwater levels. These soil-vapor wells are designed to investigate the vadose zone. Groundwater is being investigated through placement of groundwater monitoring wells. It is anticipated that soil vapor sampling tips will be installed at approximate 20-foot increments beginning at 20 feet below ground surface.

The nested soil vapor monitoring wells will be sampled after installation on a preapproved periodic basis thereafter if needed. All data will be tabulated and reviewed to determine the variation and extent of soil contaminants, establish the vapor distribution so as to better design potential vapor extraction systems (VES), and to aid in determining the efficiency and design for any potential cleanup actions, including VES.

4.5 SOIL SAMPLING

Five soil borings were drilled and sampled at seepage pit Nos. 1, 18, 26, 31, and 35 during the pre-RI investigations. Samples were collected for laboratory analyses at 10-foot intervals beginning at a depth of 10 feet below ground surface. Descriptions of the drilling and sampling procedures, the boring logs, and the results of laboratory analyses for these five borings are included in the RI Work Plan (October 1993).

To continue the evaluation of non-volatile contaminants of concern in the soil at JPL, relatively undisturbed soil samples will be collected from borings drilled at each of the remaining potential contaminant source locations (Figure 4-2) accessible to a drilling rig. Each proposed soil boring will be drilled and sampled to an approximate depth of 50 to 100 feet below grade with a percussion hammer drill rig using a dual-wall drive pipe and reverse-air circulation. Soil samples will be collected for laboratory analyses at 10-foot intervals beginning at a depth of 10 feet. When drilling at alleged surface discharge areas (WP-1, WP-2, and WP-3), the field crew will closely observe soil cuttings for signs of contamination. If contamination is observed, additional soil samples will be collected in the upper 20 feet of the boring. However, at a minimum, samples will be collected at 10-foot intervals. The final sampled intervals of each boring may be altered depending on observations by field personnel and field-instrument measurements. Details of the drilling and sampling procedures are presented in Section 6.2.

Analyses of soil samples will consist of Title 26 metals, strontium, cyanide, nitrate (as N), total petroleum hydrocarbons, and total solids to determine percent moisture. In addition, soil samples from the boring drilled at Seepage Pit Nos. 23 and 24 (one location) will be analyzed for gross alpha and gross beta radioactivity. Soil samples will also be analyzed for VOCs (EPA Method 8240) if collected from potential source locations where soil-vapor samples have indicated a total VOC concentration greater than 1 mg/l.

JET PROPULSION LABORATORY

CALIFORNIA INSTITUTE OF TECHNOLOGY

SITE PLAN · FACILITY LOCATIONS

Explanation

- ● Proposed Soil Boring for OU-2 FSAP
- ■ Soil Boring Completed During Pre-RI Investigations
- Suspected Waste Disposal Area (WP-1)

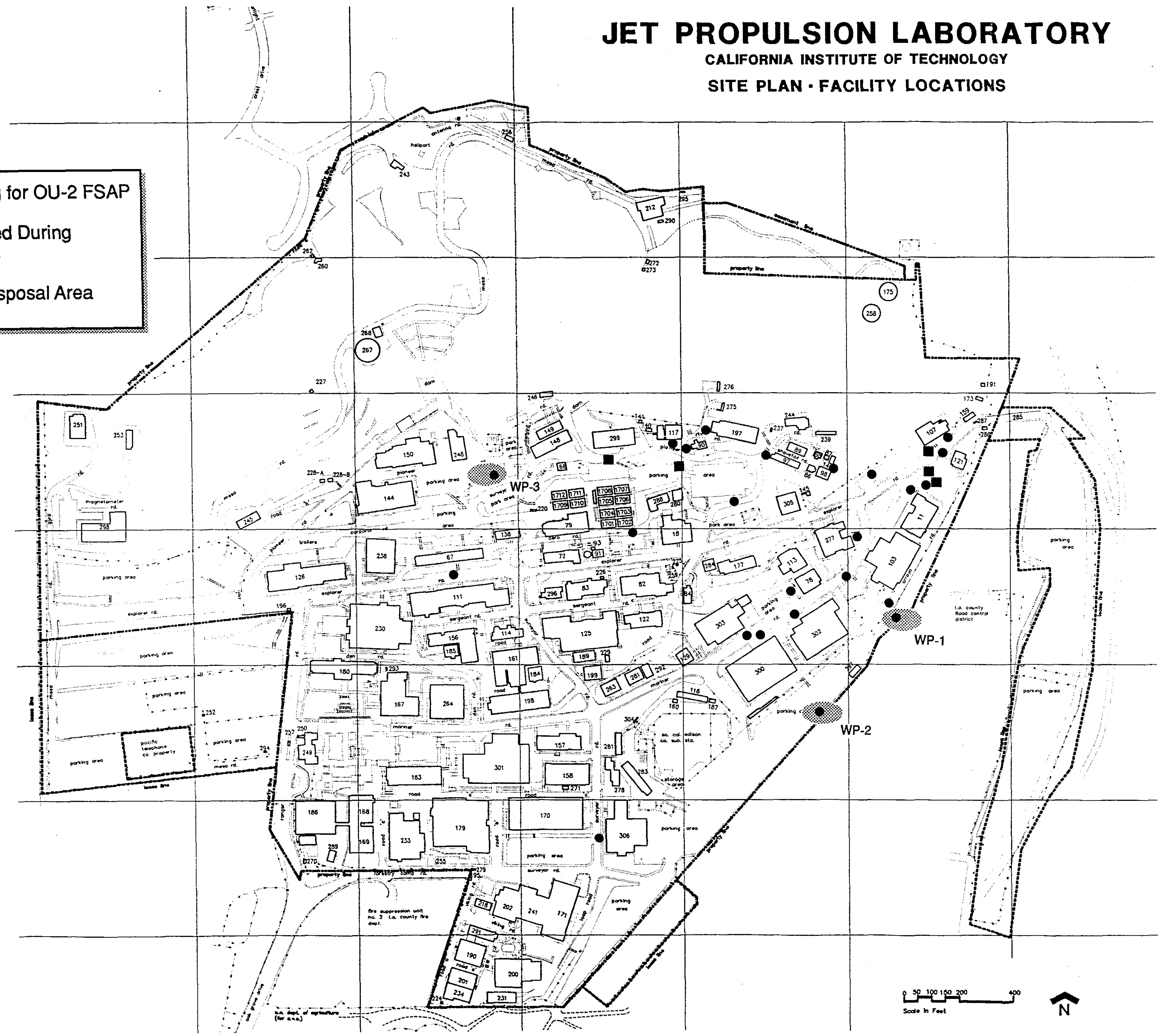


Figure 4 - 2

Proposed Accessible Soil Boring Locations

5.0 SAMPLE DESIGNATION

All soil-vapor samples and soil samples will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. Sample labels will be filled out in water-proof indelible ink at the time of sampling and the following information will be included:

- Project/site name
- Sample identification
- Date and time of collection
- Name of sampler
- Analyses requested
- Remarks, if any

The sample identifiers used for soil-vapor samples will consist of a unique alphanumeric code. Sample names for soil vapor samples will include the acronym SV (soil vapor), followed by a number indicating the sequence in which the probe was installed and sampled (e.g., SV-1). The sample identifier used for soil-vapor samples collected from the nested vapor wells will include the acronym VP for vapor probe, followed by SV, followed by a number indicating the sequence in which the probe was installed and sampled (e.g., VPSV-1). The sample identifier for soil samples will use the acronym SS (soil sample), followed by a number indicating the sequence in which the sample was collected (e.g., SS-1). Soil samples collected during the installation of each vapor well will be labeled with VP followed by SS, followed by the sequence in which the sample was collected (e.g., VPSS-1).

Duplicate soil-vapor and soil samples will also be labeled sequentially as they are collected (e.g., SS-2 or VPSS-2). Equipment blanks will be labeled with the acronym WS (water sample) followed by a number indicating the sequence in which it was collected (e.g., WS-1). This sample designation system will be used to keep each sample location and depth, as well as the identification of any QA/QC samples, unknown to the laboratory conducting the analyses. For record keeping purposes, the sample identifiers will be recorded on the chain-of-custody and in the permanently bound field log book. The permanently bound field log book will also contain each sample's location, depth, and whether it was a QA/QC sample or not (i.e., duplicate, equipment blank, water truck, Baker tank, etc.).

6.0 SAMPLING EQUIPMENT AND PROCEDURES

Descriptions of the sampling equipment and procedures to be used and followed during field activities associated with the OU-2 RI are presented in the following sections. Field activities will consist of an initial shallow soil-vapor survey, an additional shallow soil-vapor survey around locations where VOCs concentration greater than 1 milligram per liter occur, the installation of nested soil vapor monitoring wells, and a drilling and soil sampling program.

6.1 SOIL VAPOR INVESTIGATION PROCEDURES

The initial phase of field work for the OU-2 RI will consist of a shallow soil-vapor investigation. The methods and procedures used to perform the investigation are described in the following subsections.

6.1.1 Data Quality Objectives

Data Quality Objectives (DQOs) have been developed to specify the data needed to support decisions regarding RI activities. The DQOs were developed using RWQCB's "Work Plan Requirements for Active Soil Gas Investigation-Well Investigation Program (WIP)" as the guidance document (Appendix A). At the present time, the EPA has not developed guidelines for conducting a soil-vapor investigation. DQOs provided by the RWQCB cover survey design, soil-vapor sample collection, sample analyses, data interpretation/report of findings, and companion soil sampling.

6.1.2 Shallow Soil Vapor Survey Procedures

Prior to collecting soil-vapor samples at each sampling location, all probes and drive pipe used during the shallow soil-vapor survey shall be decontaminated following the procedures described in Section 6.1.7.

Soil vapor sampling probes will be installed using either a van-mounted hydraulic ram driving/hammering system or a portable manual hammering system. The hydraulic ram system will be used where a mobile sampling van can gain access. The system usually uses two hydraulic rams mounted vertically at the back of the vehicle to push, or drive, the probe into the ground. The sampling probe, connected to the bottom of a section of drive pipe, will be driven downwards into the ground using the hydraulic rams. Additional sections of drive pipe will be added until the sampling depth is reached or refusal occurs.

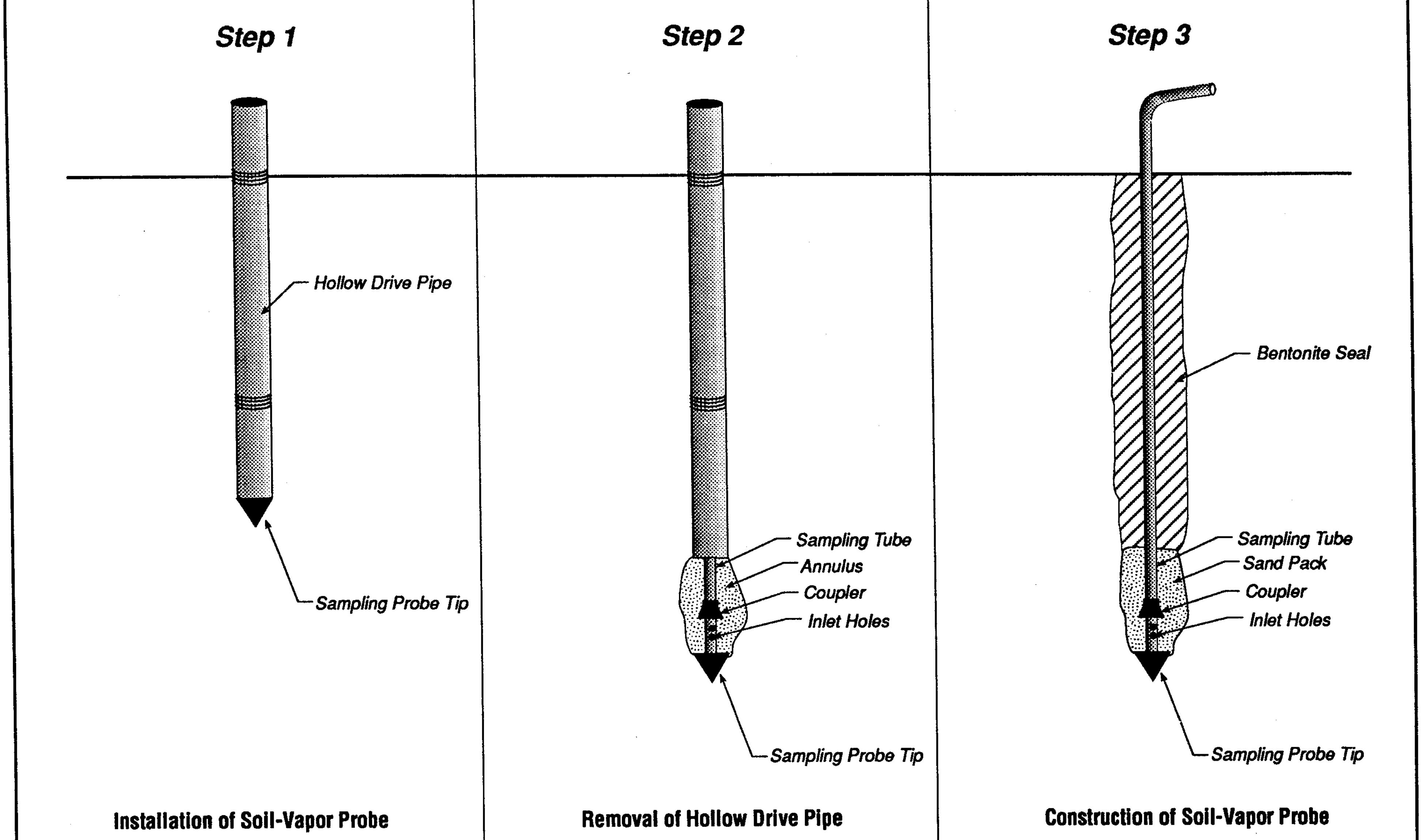
The portable, manual hammering system may be utilized in areas unaccessible to a sampling van. A sliding hammer or a jack hammer system will be attached to the top section of the drive pipe. The sampling probe connected to the bottom of the drive pipe will then be driven into the ground using the manually operated hammer. Additional sections of drive pipe will be added until the sampling depth is reached.

The soil-vapor probe will consist of a stainless steel sampling probe tip attached to silicon, Teflon®, or polypropylene nylaflow sampling tubing. The sampling probe tip is cone-shaped to facilitate the downward penetration of the sampling probe during installation.

The Teflon®, silicon, or polypropylene nylaflow sampling tubing will extend from the probe tip to the ground surface through the hollow-steel drive pipe. At the sampling depth, the hollow-steel drive pipe will be removed leaving the sampling probe in place. Soil vapor will then be able to enter the system through inlet holes located along the stem of the sampling probe tip (Figure 6-1). The inlet holes will be exposed once the drive pipe is removed.

To minimize atmospheric interference and sample dilution, soil-vapor samples will be collected at depths not less than 5 feet below grade. Once the sampling depth has been reached and the soil-vapor probe is in place, the annular space between the soil vapor sampling tube and the surrounding soil formation will be backfilled using the following procedures:

- No. 3 silica sand or equivalent will be poured into the annular space adjacent to and slightly above (approximately 1.0 feet) the perforated section of the soil vapor probe tip.
- Fine bentonite chips or granules will be placed from the top of the sand to ground surface and hydrated with distilled or deionized water. The water will be added while the bentonite is being placed to ensure hydration of the entire bentonite column.
- The top of the sampling tube will extend approximately 6 inches above grade and be capped with a Teflon®, PVC or a stainless steel plug until a sample is collected.
- Following sampling, the sampling tube will be capped, coiled and placed below grade. The remaining hole will be filled to surface with quick-set cement dyed green in paved areas. The surface cap thickness will equal that of the asphalt cover in which it resides. In unpaved areas, the hole may be completed using hydrated bentonite several inches in thickness.
- In paved areas, the soil vapor probe location shall be identified by the green cement and labeled using an indelible paint marker. In unpaved areas, a green 3-foot stake will be driven approximately 1.5 feet into the ground. The soil gas probe identity will be inscribed onto the stake using an indelible paint marker. The method to be followed for labeling the soil-vapor probe will include the acronym SV for soil vapor, followed



Not to Scale

Figure 6 - 1

Typical Installation of a Soil Vapor Sampling Probe

by the seepage pit number as identified in Table 4-1, and terminated with the depth (in feet) at which the probe is located.

- The name, location, and construction aspects of each soil-vapor probe, and a map showing the location of nearby features with distance dimensions to the probe will be documented in the permanently bound field log book.

The soil-vapor probe will be left in place to function as a semi-permanent monitoring point.

6.1.3 Equipment Calibration

At the present time, there are no methods or procedures for soil-vapor analyses that are certified by the California Department of Health Services (DHS) or by the EPA. Only the analytical equipment are laboratory certifiable. Therefore, all soil-vapor sampling, equipment calibrations, and analyses will be conducted in accordance with the guidelines and protocols described in RWQCB's "Work Plan Requirements for Active Soil Gas Investigation, Well Investigation Program (WIP)" (Appendix A).

Each soil-vapor calibration shall include the 22 Primary Target Compounds (chlorinated volatile organic and aromatic hydrocarbons) required by the RWQCB (Table 6-1). Method Detection Limits (MDLs) for each analysis completed will be between 0.01 and 1.0 micrograms per liter (μg/l).

The analytical equipment used to analyze the soil-vapor samples will be calibrated using high-purity solvent-based standards obtained from certified vendors. Standards are typically prepared in a high-purity methanol or dodecane solvent. Typically, calibration using solvent-based standards is performed by using a variety of injection volumes of the standard without dilution. If necessary, stock solvent-based standards can be diluted to appropriate concentrations. Standards prepared by dilution are formulated by introducing a known volume of stock solvent-based standard into a known volume of high-purity solvent.

Initial instrument calibration, for volatile organic compounds using EPA Method 8010/8020, is completed using a minimum of three standard injections to establish a multi-point calibration curve. This calibration may be completed off the site before field work begins. Identification and quantification of compounds in the field is based on calibration under the same analytical conditions as for multi-point calibration.

Once in the field, a one-point (mid-point) calibration is required for the gas chromatograph which includes a minimum of nine calibration standards, including three aromatic compounds and six halogenated compounds representing short, medium, and long retention time groups.

TABLE 6-1

LIST OF TWENTY TWO PRIMARY TARGET COMPOUNDS (CHLORINATED VOLATILE ORGANICS AND AROMATIC HYDROCARBONS)

1. Carbon Tetrachloride
2. Chlorobenzene
3. Chloroethane
4. Dibromochloromethane
5. Dichlorodifluoromethane
6. 1,1-Dichloroethane
7. 1,2-Dichloroethane
8. 1,1-Dichloroethene
9. cis- and trans-1,2-Dichloroethene
10. Dichloromethane
11. 1,1,2,2-Tetrachloroethane
12. 1,1,1,2-Tetrachloroethane
13. Tetrachloroethene
14. 1,1,1-Trichloroethane
15. 1,1,2-Trichloroethane
16. Trichloroethene
17. Trichlorofluoromethane
18. Vinyl Chloride
19. Benzene
20. Ethylbenzene
21. Toluene
22. Xylenes

Source: RWQCB - Los Angeles Region "Work Plan Requirements for Active Soil Gas Investigation - Well Investigation Program (WIP)".

One-point calibrations are performed prior to the first sample analysis for each day. The calibration is performed for all compounds detected at the site to ensure accurate quantification. Additional runs may be necessary if compounds other than the nine calibration standards are found. The response factor for each of the compounds must be within 15 percent of the corresponding value from the three-point (initial) calibration, otherwise the three-point calibration of the gas chromatograph must be redone. Subsequent calibration episodes, if deemed necessary, consist of at least one injection of the standard exhibiting a similar detector response as that of samples encountered in the field.

6.1.4 Sample Collection

Soil-vapor samples will be collected using the soil-vapor sampling system shown in Figure 6-2. To determine optimal site-specific purge rates and volumes, a time-series sampling of at least one probe will be performed where volatile organic compound levels are expected to be greatest. Trends in soil-vapor concentrations as a function of purge volume will be evaluated. The purge rate and time to achieve optimal purge volume will then be used. Soil-vapor samples will then be collected with a syringe from a sampling point upstream, or away from, any influence of the vacuum pump.

6.1.5 Sample Analysis

Soil-vapor samples will be analyzed in the field within 15 minutes of being collected by a mobile laboratory present on the site during sample collection. Samples will be analyzed using one or more field-operable gas chromatographs equipped with an electrolytic conductivity or Hall detector (ELCD) or electron capture detector (ECD), a photo-ionization detector (PID), and a flame-ionization detector (FID). The PID and ELCD or ECD will be used in series on columns following EPA Methods 8010/8020 protocols. Compounds analyzed will include halogenated hydrocarbons and benzene, toluene, ethylbenzene, and total xylenes. The FID will be used to detect petroleum hydrocarbons and ketones again using EPA Methods 8010/8020 protocols. Confirmatory analysis for results generated by each detector will be completed by repeating the analyses using a column different from the one initially used.

To demonstrate reproducibility of results, a duplicate soil-vapor sample will be collected and analyzed after every five samples.

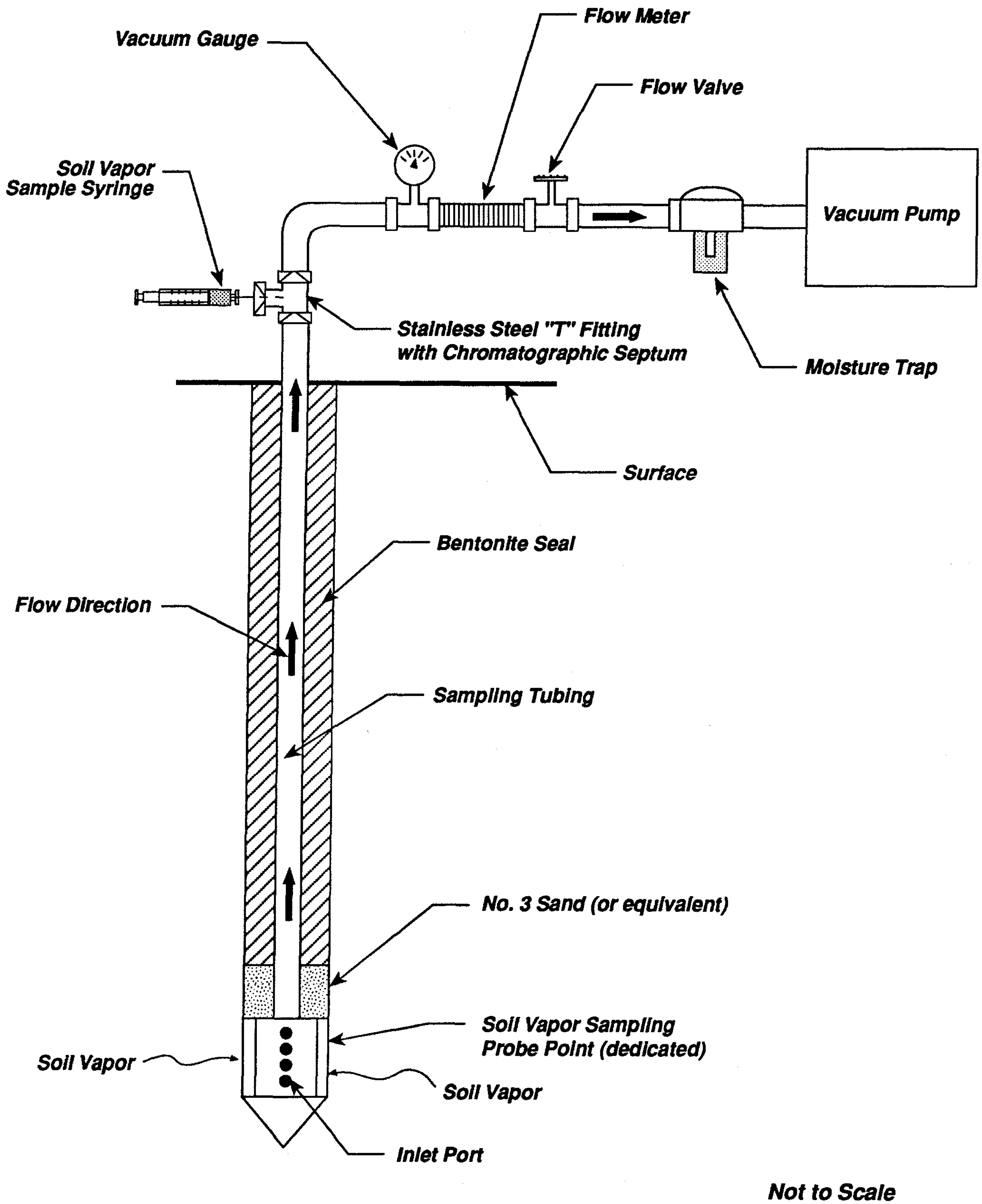


Figure 6 - 2

Soil Vapor Sampling System

6.1.6 Quality Control Procedures

All components of the sampling system will be checked for contamination prior to sampling at the beginning of the day by drawing ambient air or nitrogen gas through the system, performing a gas chromatograph (GC) analysis, and comparing the resulting chromatogram with that for ambient air or ultra-high-purity (UHP) nitrogen.

Prior to sampling each soil-vapor probe, the syringe used to collect the sample will be filled with ambient air or UHP nitrogen. The ambient air or UHP nitrogen will be injected directly into the gas chromatograph, serving as a blank to detect potential contamination of the syringe.

In addition to the daily (initial) calibration of the equipment at the beginning of the day prior to sample analysis, two QC check samples will be analyzed every 10 to 15 environmental samples, one at the beginning and one at the end of each sample batch. One QC check sample will be analyzed during the middle of the working day while the second will be analyzed upon completion. The QC check samples will be obtained from a source different from the initial calibration standard. Each QC check sample will contain a minimum of nine compounds to be checked with the response value for each compound being within 20 percent of the corresponding true value. If the first QC check sample fails the requirement, the problem will be resolved before proceeding with additional analysis. If the final QC check sample fails the requirement, additional QC check samples are run to verify the failure. If the failure is confirmed, the data collected since the last QC check sample will be nullified and resampling will be required.

6.1.7 Decontamination Procedures

Syringes and adapters will be cleaned with phosphate-free detergent at the end of each day and baked overnight in the gas chromatograph oven at a minimum temperature of 80°C. Probes and equipment in contact with the soil vapor sample stream will be decontaminated prior to initiation of sampling. Decontamination of all soil vapor sampling equipment, including the drive pipe, will be conducted by repeated washing and/or by baking in the gas chromatograph oven. Washing includes the use of a phosphate-free detergent (Citranox® or Liquinox®), double rinsing with deionized or distilled water, and air drying.

6.1.8 Reporting of Results

Findings and conclusions, based on field and analytical data generated during the soil-vapor investigations will be presented in the OU-2 RI report. These will consist of:

- Isoconcentration plots, where applicable, for each chlorinated volatile organic and aromatic compound detected, for total chlorinated volatile organics, and for total aromatic hydrocarbons for each sampling depth.
- Cross-section(s) depicting lithology (when available) and changes in contaminant concentration with depth.
- Tabulated results reported as mass/volume (i.e., μg/l) for all data collected during field sampling and laboratory analyses.
- A report of all chromatographic peaks detected during the sample analyses run and any tentatively identified compounds.
- All quality control data.
- An assessment of soil-vapor concentration data to aid in the identification of potential vadose zone source areas of volatile organic compounds (VOCs).
- An assessment of soil-vapor concentration data to aid in the evaluation of potential groundwater contamination by VOCs.

6.2 DRILLING AND SOIL SAMPLING

Discussed in the following subsections are the methods and procedures to be used during drilling and soil sampling activities. These activities will commence after the completion of the soil-vapor survey and analysis of data.

6.2.1 Data Quality Objectives

EPA Level IV data procedures will be used by the laboratory during all analyses. During the OU-2 field sampling activities, 100 percent of the samples collected will be transmitted to the laboratory with instructions to report the analytical results using EPA Level IV. This will be done for data validation purposes as a check on laboratory performance. Analyses will include Title 26 metals plus hexavalent chromium (with strontium), cyanide, nitrate, total solids, semi-volatile organic compounds (SVOCs) and total petroleum hydrocarbons (TPH). Soil samples may be additionally analyzed for volatile organic compounds if VOCs are detected at or above 1 mg/l during the soil-vapor survey. Soil samples collected from the boring drilled at Seepage Pit Nos. 23 and 24 will also be analyzed for radioactivity (gross alpha and gross beta). If radioactivity is detected in these samples, a small power auger (see Table 4-1, page 3 of 4) will be mobilized and used to obtain soil samples for gross alpha and gross beta analyses at Seepage Pit No. 25 from a depth of 20 feet or refusal, whichever occurs first.

6.2.2 Drilling Method and Sampling Procedures

Boreholes will be located in close proximity to the soil-vapor probe, but it shall be at least 2 feet from the probe location to avoid drainage to the soil vapor sampling device. The drilling method and procedures to be used for soil sampling activities are presented in the following subsections.

6.2.2.1 Drilling Method

The soil borings will be drilled with a percussion-hammer drilling rig that utilizes a dual-wall drive pipe and reverse-air circulation. The dual-wall percussion method of drilling can be described as a double wall pipe driven by a pneumatic- or diesel-operated drive hammer, while filtered air is forced downward through the annulus of the double wall drive pipe to the bit (Figure 6-3). The air returns upward through the inside pipe, bringing with it a continuous stream of drill cuttings. A water-mist injection may be occasionally used to assist the drilling, recover the drill cuttings, and dust control.

The drive pipe will consist of two heavy wall pipes joined together (one suspended inside the other). A neoprene O-ring will be used at each joint to prevent the air from escaping between the two pipes. A petroleum-hydrocarbon-free pipe dope will be used as the tool-joint lubricant. The external flush jointed drive pipe will not be rotated, but rather driven into the ground with the drive hammer which can be rated at over 8,000 foot pounds of energy per blow at more than 90 blows per minute. The method can penetrate sand, silt, clay, gravel, fractured rock, and cobble formations.

Withdrawal of the dual-wall pipe will be accomplished by a pulling system consisting of two 50-ton-capacity hydraulic cylinders operating a tapered slip arrangement which grips the outside of the double wall drive pipe. Handling of the drive pipe will be accomplished by means of a hydraulically operated cable lift arrangement.

Upon completion of drilling and sampling of each boring not converted to soil-vapor monitoring wells, the borehole will be backfilled to the ground surface with ¼-inch bentonite chips (e.g., Enviroplug) that will be hydrated with potable water as they are placed. The dual-wall drive pipe will be used as a tremie during backfilling operations and will be removed, one section at a time, while the bentonite chips are added. Holes in asphalt or concrete pavements will be repaired with like materials.

The outside diameter of the dual-wall drive pipe used will be between 9 and 11 inches. The outside diameter of the drill bit usually ranges from about 0.5 to 1.0 inch larger than the drive pipe. The drill bit and each segment of drive pipe will be steam cleaned before being used in each soil boring. Drill cuttings circulated by air out of the boring will go through a cyclone device before being collected in a roll-off bin or 55-gallon drums. Soil cuttings will be screened with a flame- or photo-ionization detector for organic vapors after each 10 feet of drilling for health and safety purposes (see HASP).

6.2.2.2 Sample Collection and Handling

Soil samples will be collected at 10-foot intervals beginning at a depth of 10 feet. The final sampled intervals of each boring may be altered depending on observations by field personnel and field-instrument measurements (e.g., odors, soil staining, lithology, elevated OVA readings, etc.). Soil samples will be collected with a split-spoon sampler following the procedure described below.

- Drill to the desired sampling depth using the percussion hammer drill rig with dual-wall drive pipe and reverse air circulation. The dual-wall drive pipe will not be driven below the prescribed sampling depth.
- A 2.5-inch (ID) by 18-inch-long split-spoon sampler containing three decontaminated stainless steel sample tubes (6.0 inches long and 2.5 inches in outside diameter)will be lowered on a cable down through the middle of the dual-wall drive pipe to the sampling depth. The sampler will be driven into the soil a minimum of 18 inches beyond the drill bit using a 140-pound sliding hammer with a 30-inch vertical stroke.
- The sampler will be retrieved and opened. Whenever possible, the uppermost sample tube will be used for lithologic description purposes, the middle tube for quality-control purposes, and the lowermost tube for laboratory analysis. The ends of the soil sample designated for laboratory analysis will be trimmed, covered with Teflon sheets, and capped with tightly fitting plastic end caps. After the sample is labeled, it will be sealed in a plastic bag and placed on ice in a cooler prior to being transported to the laboratory. Samples to be used for lithologic descriptions will be monitored for the presence of organic vapors with either a photo-ionization detector (PID) or a flame-ionization detector (FID) using the operation procedures presented in Appendices B and C. This will be completed for data acquisition purposes as well as for health and safety monitoring. Measured values will be recorded on the field boring log forms.

A field quality assurance (QA) sampling program will be enacted to evaluate the precision of the laboratory analyses, the effectiveness of decontaminating the sampling equipment, and sample-handling procedures. Collection of duplicate samples and equipment blanks will be included in this program. Field duplicate samples will be collected at a frequency of at least one sample for every 20 samples collected (see QAPP) throughout the drilling and sampling program. Duplicate soil samples will be collected when observed discoloration or staining from hydrocarbon compounds is encountered or when elevated OVA readings are obtained without accompanying discoloration. Duplicate samples will also be collected when no indication of contamination is present in order to check laboratory accuracy (on clean samples). It will be attempted to collect an equal number of apparently contaminated and clean samples. The samples will be collected as drilling and sampling proceed and will be used to evaluate the precision of the laboratory analytical results and, therefore, will be analyzed for the same parameters. Equipment blanks will be collected at a frequency of one per day per type of equipment (see QAPP). Equipment blanks will be used to evaluate the effectiveness of the procedures used for decontaminating the sampling equipment and whether cross contamination between soil samples is occurring from sampling equipment. Equipment blanks will be analyzed for VOCs and SVOCs only.

Two background samples will be collected in the West Parking Lot by cutting through the asphalt and drilling to native soil. Samples will be analyzed for VOCs, SVOCs, and metals. This area was selected because aerial photographs show the area as an undeveloped field followed by a paved parking lot. It is indicated by the photographs that the parking lot has been paved for at least 29 years.

6.2.3 Soil Description and Documentation

Lithologic descriptions of the soil cuttings and soil samples using the Unified Soil Classification System (Figure 6-4) will be recorded on the field boring logs (Figure 6-5) along with the following:

- Physical characterization and grain size distribution of the sample
- Stratigraphic boundaries
- Presence of any inferred visible contaminants
- Color changes
- Moisture content
- Thickness of individual units
- Locations of samples taken and percentage of sample recovery
- Odors and OVA or OVM measurements
- Any other conditions encountered during drilling (i.e., changes in drilling rate, etc.)

In addition to the boring log form, all other pertinent information relating to all aspects of field work will be recorded in a bound field notebook.

6.2.4 Soil Sample Analysis

All soil samples collected as part of the OU-2 FSAP will be submitted to a laboratory certified by the California Department of Health Services (CDHS). Soil samples will be analyzed for those parameters presented in Table 6-2. The analyses will include Title 26 metals (EPA Method 6010/7000 series), hexavalent chromium (EPA Method 7196/7197) strontium (EPA Method 6010/7000 series), cyanide (EPA Method 9010), nitrate (EPA Method 300.0), total solids (EPA Method 160.3), radioactivity (EPA Method 900.0) at Seepage Pit Nos. 23 and 24 (one boring) only, SVOCs (EPA Method 8270), and TPH (EPA Method 418.1). The analyses to be conducted for each sample depth in all soil borings are summarized in Table 6-3. At locations where total VOCs in the soil-vapor exceeded 1 mg/l, soil samples will be additionally analyzed for VOCs using EPA Method 8240. Duplicate soil samples will be analyzed for the same parameters. Equipment blanks will be analyzed for VOCs using EPA Method 8240 and SVOCs using EPA Method 8270.

6.2.5 Decontamination Procedures

All equipment used in the collection of soil samples at JPL will be decontaminated prior to use. The sampling equipment, consisting of a split-spoon sampler and sample tubes, will be washed with a non-phosphate detergent (i.e., Citranox®, Liquinox®) solution followed by a double rinse with deionized or distilled water, and air dried before use. Personnel directly involved in sampling equipment decontamination will wear protective clothing as specified in the Health and Safety Plan. Decontamination wastewater will be stored in a portable tank or drum(s), sampled, and analyzed to determine proper disposal pursuant to EPA guidance on the management of investigation-derived wastes (EPA, 1991 and 1992).

6.2.6 Storage and Disposal of Drill Cuttings

All drill cuttings generated during the field investigation will be collected and stored. During drilling activities, the soil cuttings will be placed in 55-gallon drums or roll-off bins. The analytical results from the soil samples collected during drilling operations will be used to determine the proper method of their disposal. If soils are determined to be contaminated, they will be stored on site until the appropriate method of disposal can be arranged pursuant to EPA guidance on the management of investigation-derived wastes (EPA, 1991 and 1992).

6.3 NESTED SOIL VAPOR MONITORING WELL INSTALLATION

A minimum of two nested soil vapor monitoring wells will be installed as part of the OU-2 RI. The locations of these wells will correspond with those locations where the highest VOC concentrations were detected during the soil-vapor survey. Each nested well will be installed in a soil boring drilled during the soil sampling program. It is anticipated that the soil boring will be drilled as close as possible, but not closer than 2 feet, of the soil vapor sampling

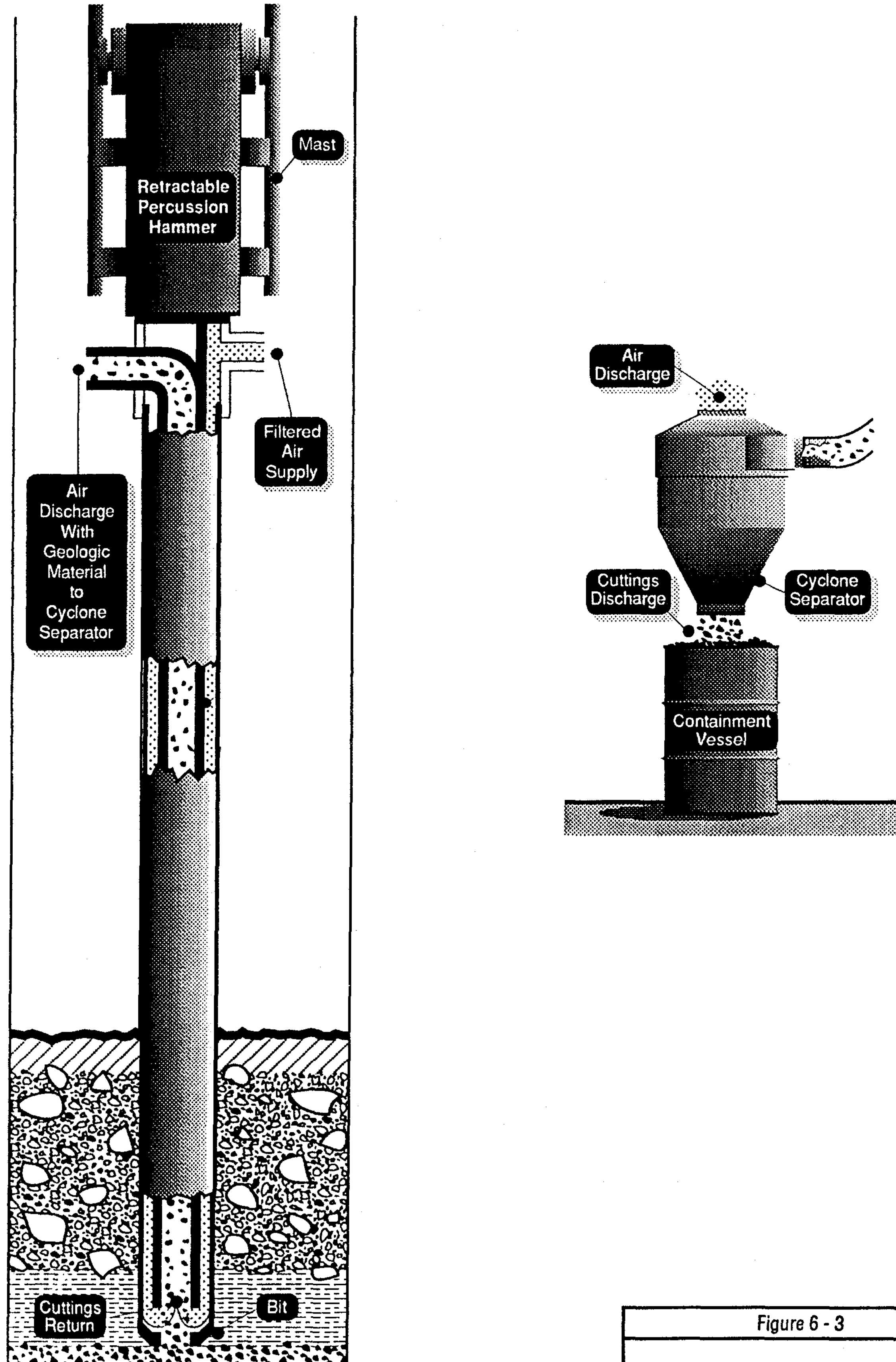


Figure 6 - 3

Generalized Drawing of Dual-Wall Percussion Method of Drilling

Unified Soil Classification System

Major Divisions			USCS Symbol	Description
Coarse-Grained Soils More than half of material is larger than No. 200 Sieve Size	Gravel More than half of coarse fraction is larger than No. 4 Sieve Size	Clean Gravels (little or no fines)	GW	Well-graded gravel or gravel sand mixtures, little or no fines. (Wide range of grain sizes and substantial amounts of all intermediate particle sizes)
			GP	Poorly-graded gravels or gravel sand mixtures, little or no fines. (Predominately one size or range of sizes with some intermediate sizes missing)
		Gravels with Fines (appreciable amount of fines)	GM	Silty gravels, gravel-sand-clay mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	Sands More than half of coarse fraction is smaller than No. 4 Sieve Size (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 Sieve Size)	Clean Sands (little or no fines)	SW	Well-graded sands or gravelly sands, little or no fines. (Wide range of grain sizes and substantial amounts of all intermediate particle sizes)
			SP	Poorly-graded sands or gravelly sands, little or no fines. (Predominately one size or range of sizes with some intermediate sizes missing)
		Sands with Fines (appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
Fine-Grained Soils More than half of material is smaller than No. 200 Sieve Size	Silts and Clays		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silt-clays of low plasticity.
			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity.
Highly Organic Soils			Pt	Peat and other highly organic soils. (Readily identified by color, odor, spongy feel, and frequently by fibrous texture.)

The No. 200 Sieve Size is about the smallest particle visible to the naked eye

PARTICLE SIZE LIMITS

SILT OR CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

No.200 — No.40 — No. 10 — No. 4 — 3/4 in — 3 in — (12 in)

U.S. STANDARD SIEVE SIZE

CONSISTENCY CLASSIFICATION

Granular Soil

Density	Abbrv.	Blows/Foot
Very Loose	VL	0 — 4
Loose	L	5 — 10
Medium Dense	MD	11 — 30
Dense	D	31 — 50
Very Dense	VD	Over 50

Bedrock	Abbrv.
Very Soft	VS
Soft	SO
Moderately Hard	MH
Hard	H
Very Hard	VH

Cohesive Soil

Consistency	Abbrv.	Field Identification
Very Soft	VS	Easily penetrated several inches by fist
Soft	SO	Easily penetrated several inches by thumb
Medium Stiff	MS	Can be penetrated several inches by thumb/moderate effort
Stiff	ST	Readily indented by thumb/penetrated only with great effort
Very Stiff	VS	Readily indented by thumbnail
Hard	H	Indented with difficulty by thumbnail

Soil Odor

Odor	Abbrv.
None	N
Light Hydrocarbon	LH
Mod. Hydrocarbon	MH
Strong Hydrocarbon	SH
Alcohol	A
Humis	H
Musty	M
Foul	F
Diesel	D
Gasoline	G
Sulfur	S
Turpentine	T

Soil Color

Color	Abbrv.
Light Brown	LB
Yellow Brown	YB
Brown	B
Dark Brown	DB
Grayish Brown	GB
Reddish Brown	RB
Dark Red	DR
Grayish Red	GR
Red	R
Yellowish Red	YR
White	W
Light Gray	LG
Gray	G
Dark Gray	DG
Yellow	Y
Pale Yellow	PY
Grayish Yellow	GY
Black	B
Tan	T
Light Red	LR

Moisture Condition

Condition	Abbrv.
Dry	DR
Slightly Moist	SM
Moist	MO
Wet	WT
Saturated	ST

Other Symbols

R - Undisturbed sample
B - Bulk Sample
▼ Ground water
◆ Groundwater sepage

Reference: Modified after the Unified Soil Classification System, Corps of Engineers, U.S. Army Technical Memorandum No. 3-357, Volume I, March, 1953 (Revised April, 1960)

Figure 6-4

United Soil Classification System

EBASCO ENVIRONMENTAL

FIELD BORING LOG

LOCATION OF BORING/WELL:	OFS NUMBER	CLIENT/LOCATION
	DRILLING CO./METHOD:	BORING /WELL NUMBER
	SAMPLING METHOD:	SHEET OF
	BACKGROUND CONDITIONS:	DRILLING
	SURFACE CONDITIONS:	START TIME / FINISH TIME
DATUM:	NOTES:	DATE / DATE

GEOLOGIST:

REVIEWED BY:

TYPE OF INSTRUMENT/SERIAL #:

CALIBRATION DATE/GAS:

SAMPLING METHOD:

SAMPLING ANALYSIS:

PERSONAL H & S SAMPLES: ☐ YES ☐ NO

PERSON SAMPLED:

SAMPLE NUMBER / SAMPLE DEPTH	TIME	SAMPLER BLOWS/FT.	INCHES DRIVEN / INCHES RECOVERED	INSTRUMENT: AUGER	INSTRUMENT: SAMPLE	INSTRUMENT: BREATHING ZONE	DEPTH IN FEET	USCS SOIL TYPE	
							0		
							1		
							2		
							3		
							4		
							5		
							6		
							7		
							8		
							9		
							0		
							1		
							2		
							3		
							4		
							5		
							6		
							7		
							8		
							9		
							0		
							1		

F-1

Figure 6- 5

Sample Boring Log Form

TABLE 6-2

SUMMARY OF LABORATORY ANALYSES AND CONTAINER REQUIREMENTS FOR SOIL SAMPLES

Parameter	EPA Method	Container	Preservative	Maximum Holding Time	Required Detection mg/kg
Volatile Organic Compounds	8240	Stainless steel sleeve	Ice	7 days	See QAPP
Semi-Volatile Organic Compounds	8270	Stainless steel sleeve	Ice	14 days for extraction & 40 days for analysis	See QAPP
Total Petroleum Hydrocarbons	418.1	Stainless steel sleeve	Ice	28 days	25
Title 26 Metals + Sr		Stainless steel sleeve	Ice		
Silver (Ag)	6010/7000 Series			6 months	10
Arsenic (As)	6010/7000 Series			6 months	5
Barium (Ba)	6010/7000 Series			6 months	50
Beryllium (Be)	6010/7000 Series			6 months	4
Cadmium (Cd)	6010/7000 Series			6 months	5
Chromium (Total) (Cr)	6010/7000 Series			6 months	10
Cobalt (Co)	6010/7000 Series			6 months	50
Copper (Cu)	6010/7000 Series			6 months	25
Mercury (Hg)	7470/7471 Series			28 days	2
Molybdenum (Mo)	6010/7000 Series			6 months	5
Nickel (Ni)	6010/7000 Series			6 months	40
Lead (Pb)	6010/7000 Series			6 months	3
Antimony (Sb)	6010/7000 Series			6 months	6
Selenium (Se)	6010/7000 Series			6 months	5
Thallium (Tl)	6010/7000 Series			6 months	10
Vanadium (V)	6010/7000 Series			6 months	50
Zinc (Zn)	6010/7000 Series			6 months	20
Strontium (Sr)	6010/7000 Series			6 months	10
Hexavalent Chromium	7196/7197	Stainless steel sleeve	Ice	24 hours	1
Cyanide	9010	Stainless steel sleeve	Ice	14 days	10
Nitrate (as N)	300.0	Stainless steel sleeve	Ice	28 days	5
Total Solids (Soil Moisture)	160.3	Stainless steel sleeve	Ice	7 days	NA
Radioactivity*					
Gross Alpha/Beta	900.0	Stainless steel sleeve	Ice	6 months	5 pCi/g

*Seepage Pit Nos. 23 and 24 only.
NA - Not applicable
mg/kg - milligrams per kilogram
pCi/g - Picocuries per gram

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TABLE 6-3

SOIL SAMPLE ANALYSES FOR ALL BORINGS

Depth (feet)	Title 26 Metals and Strontium EPA 6010/7000 Hexavalent Chromium EPA 7916/7197	Nitrate EPA 300.0	Total Solids EPA 160.3	Cyanide EPA 9010	Total Petroleum Hydrocarbons EPA 418.1	Semi-Volatile Organic Compounds EPA 8270
10	X	X	X	X	X	X
20	X	X	X	X	X	X
30	X	X	X	X	X	X
40	X	X	X	X	X	X
50	X	X	X	X	X	X
60	X	X	X	X	X	X
70	X	X	X	X	X	X
80	X	X	X	X	X	X
90	X	X	X	X	X	X
100	X	X	X	X	X	X

<u>Notes</u>:

1. Samples from boring at Seepage Pit Nos. 23 and 24 shall also be analyzed for gross alpha and gross beta (EPA Method 900.0).

2. Soil samples analyzed for volatile organic compounds (EPA Method 8240) will be dependent on the results of the soil-vapor survey.

location. Procedures and methods to be followed during this part of the OU-2 RI are discussed in the following subsections.

6.3.1 Well Permit Requirements

Prior to installing soil-vapor wells, all necessary permits will be obtained provided that the project schedule is not impacted. Permits from the County of Los Angeles Department of Health Services - Public Health Programs - Environmental Health will be obtained for each proposed vapor monitoring well that will be greater than 50 feet in depth provided that the project schedule is not impacted. A copy of the well permit application is presented in Figure 6-6. A summary of vapor monitoring well permitting details for JPL is shown in Table 6-4.

6.3.2 Nested Soil Vapor Monitoring Well Construction Procedures

Nested soil-vapor monitoring wells will be installed in previously drilled soil borings (Section 6.2.2.1) to establish a vertical profile of VOC concentrations within the vadose zone at each location. The design of a typical soil vapor monitoring well is illustrated in Figure 6-7. Each vapor well will be constructed according to the following general procedures:

- The total depth of each nested soil-vapor well is expected to be 100 feet or less depending on if groundwater is encountered. If groundwater is encountered, the bottom of the nested soil vapor well will be positioned several feet above the measured static groundwater level.
- Each nested soil-vapor well will consist of five soil-vapor sampling points installed at approximately 20-foot increments beginning at 20 feet below grade. Final depths of the soil-vapor sampling points may vary on the basis of lithology (i.e., located in more permeable soil), VOC concentrations detected by the OVA or OVM (i.e., area of most elevated concentration) while drilling, odor of soil cuttings, or visible staining of soil cuttings. If a well is installed to less than 100 feet, soil-vapor sampling points will be placed based on the factors mentioned previously, but no more than five sampling points would be installed.
- The soil-vapor probe and assembly will consist of a stainless steel soil vapor sampling probe tip attached to a sampling tubing terminating at a surface sampling port. The sampling tip configuration and inside diameter of the tubing will be dependent on the equipment provided by the sampling subcontractor.
- Before installation, each soil-vapor probe and attached sampling-tube assembly will be measured to verify proper depth placement.
- The drill pipe will act as a tremie pipe during the backfilling procedure and will be removed one section at a time as the backfilling material is added.
- A minimum 2-foot-thick bentonite seal will be placed at the bottom of each borehole to form a seal below the deepest interval to be monitored.

- A filter pack, consisting of No. 3 sand or equivalent, will be placed adjacent to each soil-vapor probe sampling point and will extend 1 foot above and below each sampling point.
- The remaining annular space between each filter pack and to ground surface will be filled with a bentonite seal. The bentonite material used will consist of 3/8-inch pellets or chips or smaller and will be hydrated with deionized or distilled water as it is being placed within the hole.
- The backfilling procedure will be carefully monitored by frequent depth measurements with a weighted depth meter to ensure that no bridging has occurred during placement and the proper dimensions of backfill materials have been achieved.
- A locking monument cover, or traffic box (12-inch-diameter, minimum) if located in an area of vehicular or pedestrian traffic, will be installed at each well after the bentonite has had time to cure. Concrete will be used to secure the monument cover or traffic box in place.
- When a traffic box is used, it will be set slightly above surrounding grade to direct surface water runoff away from the well.

6.4 EQUIPMENT LIST

An equipment check list for items which will be required for drilling and soil sampling activities is presented in Table 6-5. Prior to initiating field work, field personnel will use the list to ensure that the identified items have been obtained before mobilization.

SERVICE APPLICATION AND FEE COLLECTION
COUNTY OF LOS ANGELES - DEPARTMENT OF HEALTH SERVICES
PUBLIC HEALTH PROGRAMS - ENVIRONMENTAL HEALTH
SERVICE REQUEST APPLICATION

INSTRUCTIONS

1. Check the TYPE OF SERVICE requested and attach the required non-refundable fee to the application. Make money order or check payable to LOS ANGELES COUNTY TREASURER, DO NOT SEND CASH. This application is nontransferable.

FEE REQUIRED*		TYPE OF SERVICE
______	☐	MONITORING WELL CONSTRUCTION/DESTRUCTION
______	☐	WELL CONSTRUCTION, RENOVATION OR DESTRUCTION PERMIT Complete and attach a Well Permit Application
______	☐	PRIVATE SEWAGE DISPOSAL SYSTEM CONSTRUCTION PERMIT
______	☐	PRIVATE SEWAGE DISPOSAL SYSTEM RENOVATION/EXPANSION
______	☐	INSPECTION OF MOUNTAIN CABIN SITE as required by the United States Forest Service
______	☐	INSPECTION OF EXISTING PRIVATE SEWAGE SYSTEM as required by FHA/VA
______	☐	WATER SUPPLY TEST AND CERTIFICATION as required by U.S. Department of Agriculture

2. Check with Contact Office stamped below for requirements or information.
3. Complete the required information or deliver the completed application, money order or check with the forms indicated.

to: County of Los Angeles
Department of Health Services
Public Health Programs
Environmental Health
2525 Corporate Place
Monterey Park, Ca 91754
(213) 881-4147

*Refer to Schedule of Fees for current fiscal year.

NOTE: FIELD PERSONNEL CANNOT ACCEPT FEES.

4. Phone Contact Office noted below, after you have received your receipt, to request an inspection.

Service/Job Location Address ______ Date ______

Owner/Applicant's Name ______ Address ______ Phone No. ______

Contractor's Name ______ Address ______ Phone No. ______

Co. Engineer Plan Check No.______ Tract No. ______ Lot No. ______ No. Bedrooms ____
(Complete line above for Private Sewage Disposal System Construction or Renovation Application)

CONTACT OFFICE	DEPARTMENT STAMP

765979 - H2124 (Rev. 3/91) WHITE: CHIEF COPY CANARY: APPLICANT COPY PINK: SENIOR COPY

APPLICATION FOR WELL PERMIT

ENVIRONMENTAL HEALTH 2525 Corporate Place Monterey Park, Ca 91754
COUNTY OF LOS ANGELES DEPARTMENT OF HEALTH SERVICES

DATE ______

DESCRIPTION

TYPE OF PERMIT (CHECK)
- ☐ NEW WELL CONSTRUCTION
- ☐ RECONSTRUCTION OR RENOVATION
- ☐ DESTRUCTION

TYPE OF WELL
- ☐ PRIVATE DOMESTIC
- ☐ PUBLIC DOMESTIC
- ☐ IRRIGATION
- ☐ OBSERVATION/MONITORING
- ☐ CATHODIC
- ☐ INDUSTRIAL
- ☐ GRAVEL PACK
- ☐ TEST

TYPE OF CASING ______

METHOD OF SEALING OF CASING ______

METHOD OF DESTRUCTION ______

LOCATION

ADDRESS (NUMBER, STREET, AND NEAREST INTERSECTION) ______ CITY ______

DIAGRAM (SHOW PROPERTY LINES, STREET, ADDRESS, WELL SITE, SEWERS, AND PRIVATE SEWAGE DISPOSAL SYSTEMS ALONG WITH LABELS AND DIMENSIONS)

APPLICANT

NAME OF WELL DRILLER (PRINT)	NAME OF WELL OWNER (PRINT)
TRADE NAME	MAILING ADDRESS
BUSINESS ADDRESS CITY	CITY

I hereby agree to comply in every respect with all regulations of the County Preventive/Public Health Services and with all ordinances and laws of the County of Los Angeles and of the State of California pertaining to well construction, reconstruction and destruction. Upon completion of well and within ten days thereafter, I will furnish the County Preventive/Public Health Services with a complete log of the well, giving date drilled, depth of well, all perforations in casing, and any other data deemed necessary by such County Preventive/Public Health Services.

______
Applicant's Signature

DISPOSITION OF APPLICATION: (For Sanitarians Use Only)
- ☐ APPROVED
- ☐ DENIED
- ☐ APPROVED WITH CONDITIONS

If denied or approved with conditions, report reason or conditions here:

DATE	SANITARIAN
DATE	SECTION CHIEF

When signed by Section Chief, this application is a permit.

76A668
H-13 (Rev. 3/91)

Please Return All Copies

Note: Permits will be obtained only if the project schedule is not impacted.

Figure 6 - 6

Application Form for a Soil Vapor Well Permit

TABLE 6-4

SUMMARY OF SOIL VAPOR MONITORING WELL PERMITTING DETAILS*

Agency	Applicable Well Locations	Contact	Permit Applications	Follow-up Requirements
County of Los Angeles Department of Health Services Public Health Programs Environmental Health 2525 Corporate Place Monterey Park, CA 91754	On JPL property not in City of Pasadena	San Gabriel Valley area: Mr. Dave Kinney (818) 308-5374	Submit completed application forms with permit fee of $107/well a minimum of 2 weeks before work is to commence.	Submit completed well log with details of well installation (date, depth, screen interval, etc.) within ten days of well completion.

* Permits will be obtained only if the project schedule is not impacted.

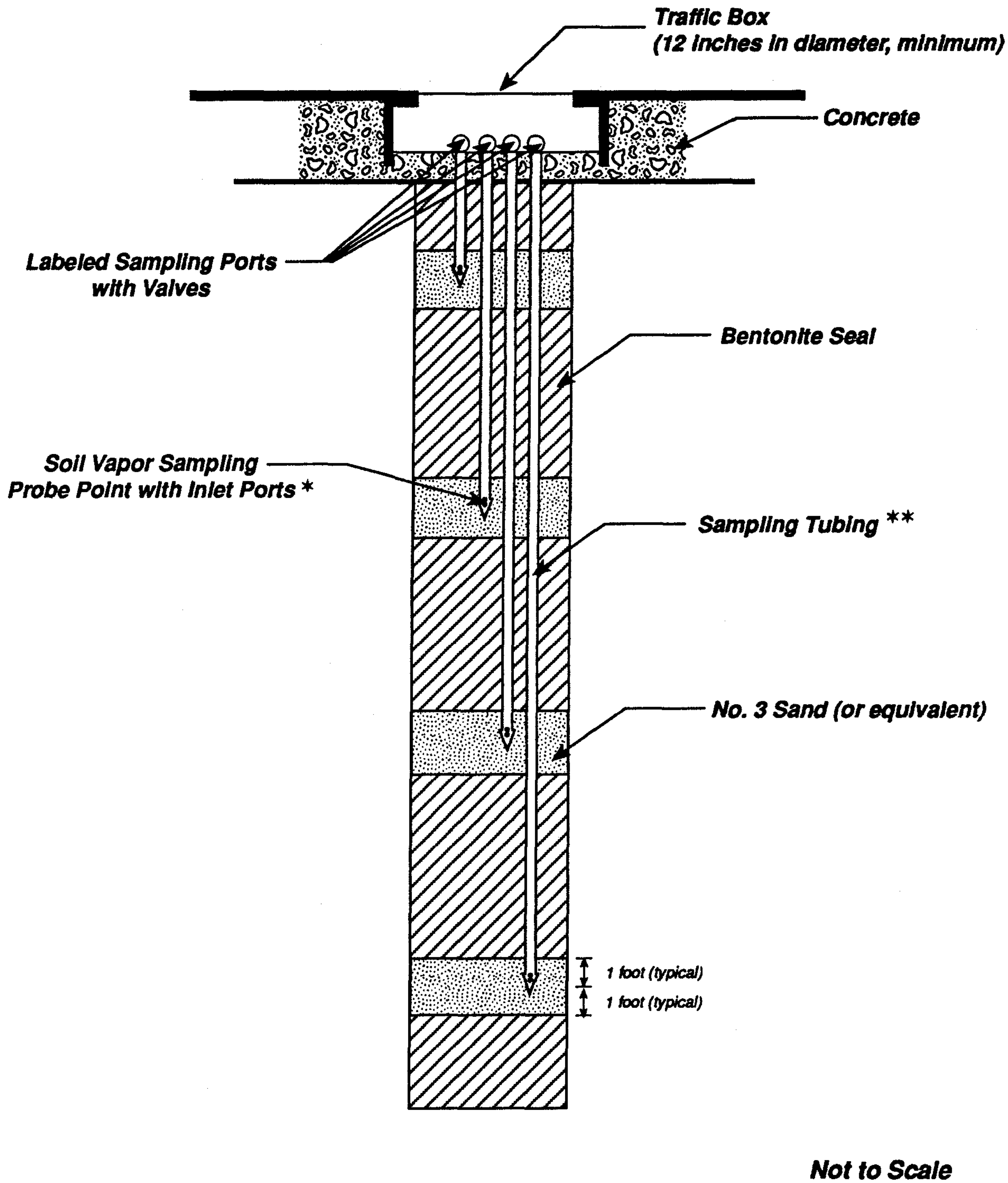


Figure 6-7

Typical Construction of a Nested Soil Vapor Monitoring Well

* Depths to sampling probe points are variable (see section 6.3.2).
** Size dependent on subcontractor's equipment.

- A locking monument cover, or traffic box (12-inch-diameter, minimum) if located in an area of vehicular or pedestrian traffic, will be installed at each well after the bentonite has had time to cure. Concrete will be used to secure the monument cover or traffic box in place.
- When a traffic box is used, it will be set slightly above surrounding grade to direct surface water runoff away from the well.

6.4 EQUIPMENT LIST

An equipment check list for items which will be required for drilling and soil sampling activities is presented in Table 6-5. Prior to initiating field work, field personnel will use the list to ensure that the identified items have been obtained before mobilization.

TABLE 6-5

EQUIPMENT INVENTORY CHECKLIST FOR SOIL SAMPLING AT THE JET PROPULSION LABORATORY

____	Field Sampling and Analysis Plan	____	Sample Labels
____	Chain-of-Custody Forms	____	Cooler(s) with Ice
____	Equipment Calibration Forms	____	Packaging Tape or Silicon Tape
____	Boring Log Forms	____	Distilled or Deionized Water
____	Bound Field Logbook	____	Sample Sleeves
____	Pens and Pencils	____	Teflon Sheets
____	Indelible Ink Markers	____	Plastic End-Caps (sample sleeves)
____	Calculator	____	Non-Phosphate Detergent
____	Important Names and Phone Numbers	____	5-Gallon Buckets (3), Brushes
____	Bottle of HCl Solution	____	Duct Tape
____	Hard Hat	____	Scissors, Wrenches, Pliers, Screwdrivers, etc
____	Munsell Soil Color Chart	____	Electronic Water Level Meter
____	Nitrile Gloves		– Spare Batteries (9 Volt)
____	Latex Gloves		– 300 Feet Graduated Cable
____	Knife	____	Organic Vapor Analyzer (Foxboro OVA 108)
____	Safety Glasses		– Calibration Gases
____	Ear Plugs		1) 95 ppm Methane
____	Steel-Toed Boots		2) 0.25% Methane
____	Tyvek Coveralls		– Adjustable Wrench
____	Visqueen Plastic	____	Organic Vapor Meter (OVM) (if OVA not available):
____	First-Aid Kit		– Isobutylene Standard
____	Large Trash Bags		– Collapsible Polyethylene Bag
____	Folding Card Table		
____	Self-Sealing Plastic Bags		

7.0 SAMPLE TRANSPORT AND CUSTODY

Analysis of all soil samples will be performed by a laboratory certified by the CDHS. The soil vapor samples will be analyzed on-site with a mobile laboratory. Therefore, the sample handling procedures for soil samples only are described in the following section. Maximum holding times for each analytical method will be strictly observed (Table 6-2). Laboratory reports of the analytical results will be reviewed according to procedures described in the Quality Assurance Project Plan (QAPP).

Sample labels will be attached to the soil sample containers following sample collection. The sample containers will then be placed in resealable plastic bags to prevent the loss of labels during shipment. Samples which require refrigeration will be placed in a cooler with ice to ensure that they remain at a temperature of 4 degrees Celsius until delivery to the laboratory.

Chain-of-custody procedures will be used to maintain and document sample possession for legal purposes. Adherence to strict document control procedures is of prime importance. The principal documents that will be used to record possession of the samples are the chain-of-custody and the field notes. A sample is considered to be in a person's custody if (1) it is in a person's physical possession, (2) it is in view of the person after that person has taken possession, (3) it is secured by that person so that no one can tamper with the sample, and (4) it is secured by that person in an area to which access is restricted.

A chain-of-custody form (Figure 7-1) will be completed by field personnel and will accompany the samples to the laboratory. The field sampler (originator) will be responsible for the care and custody of the samples from the time they are collected until they are transferred. All samples will be transported to the laboratory by courier, a laboratory representative, or field personnel. The process will ensure prompt, secure arrival and will meet the requirements of chain-of-custody procedures. For each sample shipment, the originator will complete a chain-of-custody form entering all the requested information. At a minimum the form will contain the following:

- Sample number
- Signature of sampler
- Date and time of sample collection
- Name of facility/site
- Sample type
- Analyses requested

CHAIN OF CUSTODY FORM REQUEST FOR ANALYSIS

№ 10344

Ebasco Environmental
A Division of Ebasco Services Incorporated
3000 W. MacArthur Boulevard, Santa Ana, California 92704-6993 • (714) 662-4050 • Fax (714) 662-4049

Page ___ of ___

Project Name	OFS No.	Sampling Date	HAZARD IDENTIFICATION: Nonhazard ☐ Reactive ☐ Flammable ☐ Toxic ☐ Skin Irritant ☐ Infectious ☐	Time Required NORMAL ☐ ___ DAYS RUSH ☐ ___ DAYS
Project Address		Shipment Date		
Sampler (Name)	Sampler: *(Signature)*	ANALYSES REQUIRED		
Laboratory/DHS No. :				
Reports to Be Sent to:				

SAMPLE NUMBER	TIME COLLECTED	SAMPLE PRESERVATIVE(S)	CONTAINER SIZE AND TYPE	SAMPLE MATERIAL			Halogenated Volatile Organics (8010/601)	Mod. 8015 (Gas Range)/(Diesel Range)	Aromatic Volatile Organics (8020/602)	Pesticides (8080/608)	Volatile Organics (8240/624)	Semi-Volatile Organics (8270/625)	TRPH (418.1)	Title 22 Metals	Waste Extraction Test (WET)	TCLP for Metals								
				WATER	SOIL	OTHER *(Describe)*																		

LABORATORY INSTRUCTIONS/COMMENTS:

Relinquished by: *(Signature)*	Date:	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date:	Received by: *(Signature)*
Company:	Time:	Company:	Company:	Time:	Company:

F-2

Shipping Copy (White) File Copy (Yellow) Field Copy (Pink)

Figure 7 - 1

Sample of Chain-of-Custody Form

- Sample preservation
- Identification of laboratory QC sample
- Signature of persons involved in the chain of sample possession
- Date and time of relinquishment
- Remarks - pertinent observations of the samplers

Upon receipt of the samples at the laboratory, the designated sample custodian will proceed as outlined in the QAPP. The sample recipient will cross-check the sample labels and the chain-of-custody form and document any unusual conditions in the "Remarks" section on the chain-of-custody form. The person relinquishing the samples will sign the chain-of-custody form in the appropriate box labelled "Relinquished By". The sample recipient will sign the chain-of-custody form in the appropriate box labelled "Received By". Finally, the relinquishing party will retain the "Field Copy" for record keeping.

8.0 REFERENCES

EPA, 1991. Management of Investigation-Derived Wastes During Site Inspections: USEPA Office of Research and Development, EPA/540/G-91/009, May 1991.

EPA, 1992. Guide to Management of Investigation-Derived Wastes: USEPA Office of Solid Waste and Emergency Response. Publication 9345.3-03FS, April 1992.

State of California, California Regional Water Quality Control Board - Los Angeles Region: Work Plan Requirements for Active Soil Gas Investigation Well Investigation Program (WIP), February 1992.

APPENDIX A

WORK PLAN REQUIREMENTS FOR ACTIVE SOIL GAS INVESTIGATION, WELL INVESTIGATION PROGRAM (WIP)

STATE OF CALIFORNIA
California Regional Water Quality Control Board - Los Angeles Region

WORK PLAN REQUIREMENTS FOR ACTIVE SOIL GAS INVESTIGATION WELL INVESTIGATION PROGRAM (WIP)

The objectives of these investigations are to: 1) evaluate potential waste discharges which may impact ground water, 2) determine variation and extent of soil contaminants, 3) establish vapor distribution for the design of vapor extraction system (VES), and 4) aid in determining the potential efficiency and appropriate design for any cleanup action, including VES. The work plan should include, but not be limited to, the following:

Survey Design (location, number, depth, data quality objectives)

1. Provide a scaled facility plot plan depicting potential source areas and proposed soil gas sample points. Include location and coordinate of identifiable geographic landmarks (i.e., street center-line, benchmark, street intersection or wells).

2. Locate soil gas sample points using 20-30 foot grid in potential source areas and no more than 100 foot grid for the rest of the site (coarse survey). Provide rationale for the number, location, and depth of sample points.

3. Conduct close interval (10'-20' foot grid) multi-depth sampling (3 to 5 feet between points) in areas with known soil contaminants and where prior soil gas sampling has detected relatively high levels of VOCs at the site.

4. Real time analysis of samples allows for field modification of the sampling plan (for grid density, location, and depth) based upon test results. However, field adjustments are acceptable only if the decision-making criteria are included in the approved work plan and in consultation with Board staff.

5. If anomalous data (i.e., soil gas values 2 to 3 orders of magnitude different from trends indicated by surrounding samples) are obtained from a sample point, resample and reanalyze at that point.

Sample Collection

1. Obtain samples at an adequate depth (minimally 5 feet) below the ground surface to minimize atmospheric air interference.

2. Discuss techniques to determine optimal purge rates and volumes. Minimum purging (3 probe volumes maximum) is required so that the samples are representative of VOC levels in the formation around the probe tip. At the beginning of the survey, conduct a site-specific purge volume versus contaminant concentration

test where VOC levels are expected to be highest, for major lithologic units or when significant pressure change is encountered to ensure that samples are representative of site conditions. Adjust purge rate and time to achieve optimal purge volume.

3. Explain the zone of influence for soil gas sample points, taking into consideration soil types, land cover, drive point construction, and sample purge time/rate/volume. The vertical zone of influence from soil gas purging and sampling must not intersect the ground surface.

4. Discuss procedures to minimize cross contamination between sample points.

5. Detail soil gas sample collection, handling, and testing procedures. Record the atmospheric pressure and evacuation pressure at which the sample is collected and the sample volume. Discuss procedures to prevent collection of samples under vacuum.

6. Select and specify soil gas sampling equipment (e.g., gas tight syringe) that will not affect sample integrity.

<u>Sample Analysis</u>

1. An on-site mobile laboratory with laboratory-grade certifiable instrumentation and procedures is required for real time analyses of individual VOCs. Non-specific portable organic vapor analyzers and/or GC-based handheld detectors may not be used for sample analysis.

2. Specify target compounds analysis list. Detection limits of 0.01 to 1.0 μg/l (soil gas) must be attained. Justify the use of higher detection limits.

3. Specify and justify time between sample collection and analysis.

4. Specify column characteristics, initial and final column temperatures, rate of column temperature increase per minute, calibration materials (liquid vs. gas sample) and sample flow rate employed in order to determine problems that may be associated with coeluting compounds. The chromatograms for calibration standards shall be included in the final report and provided to staff in the field for review to ensure that target compounds can be identified.

5. Provide QA/QC procedures essential for establishing support of analytical data. Include, at a minimum, field blanks, equipment blanks, initial and continuing calibration checks, laboratory

control standards, and sample replicates. Sampling equipment blank should be sampled from a contaminant-free source, if ambient air is not contaminant free.

Data Interpretation/Report of Findings

1. Methods to be used for data interpolation (contouring) must be detailed. At a minimum, where justified by the data, isoconcentration plots for each chlorinated volatile organic and aromatic hydrocarbon compound detected, and for total chlorinated volatile organics and for total aromatic hydrocarbons for each sampling depth must be presented in the final report. Provide cross-sections depicting the geology and changes in contaminant concentration with depth.

2. Data collected during field sampling and laboratory analyses must be compiled in tabular format and results are to be reported as mass/volume (i.e., µg/l).

3. Report all chromatographic peaks detected during the analyses run and any tentatively identified compounds.

Companion Soil Sampling

1. Conduct the soil sampling and VOC analyses per this Board's WIP WORK PLAN REQUIREMENTS for INITIAL SUBSURFACE INVESTIGATIONS.

2. Borehole locations and sampling intervals shall be based on soil gas survey results. Obtain discrete, undisturbed companion soil samples. Use a minimum 2-inch diameter sample tube.

3. Board staff must be part of the data review to determine companion soil sample locations and the need for additional soil/soil gas sampling.

Soil Gas Guidelines for Data Package - Initial Demonstration of Laboratory Capability

1. The data package should consist of a concise tabular summary the key elements necessary to demonstrate method proficiency.

2. Incomplete or disorganized packages are subject to delay or rejection of review.

3. All raw data including chromatograms and instrument printouts that support Data Package results should also be included. They should be properly identified for easy review. Every compound in the chromatograms should be clearly identified.

4. Summary of standards preparation for calibrations, preparation of laboratory control check samples should be included. If they are purchased, sources of the standards should be included.

5. List the operating conditions and instrumentation for each type of analyses.

6. Summary of calibration methods and determination of detection limits should be included. If one calibration standard is used for daily calibration, include results of the daily response factor and percent differences from the average RF of the calibration curve.

7. Calibrations and determination of detection limits should be done for each and every compound listed in EPA Methods 8010 and 8020. For detection limits, a sample with a concentration at detection limit should be prepared and checked for recovery. The recovery should be at least 50%.

8. For initial calibration, at least a three point calibration should be done. One point should be at the detection limit.

9. A copy of your laboratory Standard Operating Procedures (SOP) should be included. SOP should include but not limit to the following procedures.
   (a) Daily calibration method
   (b) Blank analysis
   (c) Laboratory quality control check sample analysis and frequency of this analysis during each day. For each day the last analysis should be done on QC check sample.
   (d) Procedures to handle when the sample concentration is outside the calibration linear range.
   (e) Confirmation of compounds detected
   (f) Duplicate analysis of samples
   (g) The holding time of the samples
   (h) Sample identification
   (i) QA/QC corrective actions
   (j) Report generation

List of Twenty Two (22) Primary Target Compounds (Chlorinated Volatile Organics and Aromatic Hydrocarbons)

1. Carbon Tetrachloride
2. Chlorobenzene
3. Chloroethane
4. Dibromochloromethane
5. Dichlorodifluoromethane
6. 1,1-Dichloroethane
7. 1,2-Dichloroethane
8. 1,1-Dichloroethene
9. cis- and trans-1,2-Dichloroethene
10. Dichloromethane
11. 1,1,2,2-Tetrachloroethane
12. 1,1,1,2-Tetrachloroethane
13. Tetrachloroethene
14. 1,1,1-Trichloroethane
15. 1,1,2-Trichloroethane
16. Trichloroethene
17. Trichlorofluoromethane
18. Vinyl Chloride
19. Benzene
20. Ethylbenzene
21. Toluene
22. Xylenes

QA/QC AND REPORTING REQUIREMENTS FOR SOIL GAS INVESTIGATION

Initial Calibration

Initial calibration must be performed for all compounds in the 8010/8020 list. A minimum of 3 concentrations is required, while the lowest one must not be higher than three times the Method Detection Limit (0.1-1 μg/L). Identification and quantitation of environmental compounds must be based on calibration under the same analytical conditions (i.e. column, detector, and temperature program etc.). Change in any of these conditions or calibration standard stock solution must result in a new initial calibration.

Daily Calibration and QA/QC

These must be performed and results calculated to demonstrate satisfactory running condition of the GC before any environmental sample can be analyzed.

1. 1-Point (Mid-Point) Calibration

   A minimum of 9 calibration standards, including 3 aromatics and 6 halogenated compounds representing short, medium and long retention time groups, must be checked at the beginning of a working day. One-point calibration check is required for all compounds detected at a particular site to ensure quantification, i.e. additional runs may be necessary if compounds other than the 9 calibration standards are found. Therefore it is recommendable to include commonly found volatile compounds in the initial 1-point calibration check. The response factor for each of the compounds must be within 15% of the corresponding value from the 3-point calibration, otherwise the GC must be re-calibrated.

2. Blanks

   Sampling equipment blank, ambient air sample, method blank and other appropriate blanks must be analyzed at least once at the beginning of the working day and as frequent as necessary during the rest of the day.

3. Quality Control (QC) Check Sample

   A minimum of two QC check samples (obtained from a source different from the calibration standards) must be analyzed each working day, one at the beginning and one at the end, i.e. bracketing the analysis of environmental samples. A minimum of 9 compounds as described earlier must be checked. Response for each compound must be within 20% of the corresponding true value. If the beginning QC check sample fails the requirement, the problem must be resolved before proceeding with sample analysis. If the end or any of the following QC check sample fails the requirement, then all environmental samples analyzed between the failed sample and the last acceptable QC check sample will be considered questionable. Therefore it is recommendable to run QC check samples every 10 samples to ensure acceptable analysis.

Shortening the GC Run Time

Shortening the GC run time is acceptable only if it does not hamper identification and quantification of any compounds present at the subject site. A normal run must be performed whenever peaks are detected within retention time windows where co-elution is likely as indicated by the calibration chromatograms.

Compound Confirmation

Every compound detected at a site must be confirmed by a second column or mass spectroscopy identification. Usually one sample is adequate, and quantification is not required for the confirmation run.

Evaluation Check Sample

Soil gas investigations will be randomly selected for unannounced performance evaluation by requiring on-site analysis of check samples provided by this office.

Reporting of Sample Results and QA/QC Information

1. The date and time of injection, and analytical conditions must be provided for all environmental and QA/QC samples.

2. All concentrations must be reported in $\mu g/L$.

3. For (the most recent) initial calibration, the retention time and average response factor (RF) for each compound must be reported.

4. For daily 1-point calibration, the RF and percent difference from initial RF for each compound must be tabulated and reported.

5. For QC check samples, the true concentration, detected concentration, and percentage difference for each compound must be tabulated and reported.

6. For environmental samples, including any duplicates, the sample identification, sampling depth, purge volume, vacuum pressure, sampling time, injection time, injection volume, results, and any other sampling or analytical remarks, must be reported in a tabulated format. Unidentified or tentatively identified peaks must also be listed.

7. Chromatograms for calibration standards, QC check samples, and selected samples (e.g. samples with most compounds, highest concentrations, infrequent compounds, and representative samples for different source areas) must be submitted upon request.

8. Sample report forms containing all required sampling, analytical and QA/QC information are attached for references.

SOIL GAS INITIAL CALIBRATION STANDARD REPORT

DATE: ____________ ANALYST: ____________ STD SOURCE: ____________ MACHINE ID: ____________

COMPOUND	DETECTOR	1st CONC ______				2nd CONC ______				3rd CONC ______				RF_{ave}	SD	%RSD
		RT	MASS	AREA	RF	RT	MASS	AREA	RF	RT	MASS	AREA	RF			
Bromobenzene																
Bromodichloromethane																
Bromoform																
Bromomethane																
Carbon tetrachloride																
Chloroethane																
Chloroform																
Chloromethane																
Dibromochloromethane																
Dibromomethane																
Dichloromethane																
1,1-Dichloroethane																
1,2-Dichloroethane																
1,1-Dichloroethene																
c-1,2-Dichloroethene																
t-1,2-Dichloroethene																
1,2-Dichloropropane																
c-1,3-Dichloropropene																
t-1,3-Dichloropropene																
1,1,1,2-Tetrachloroethane																
1,1,2,2-Tetrachloroethane																
Tetrachloroethene																
1,1,1-Trichloroethane																
1,1,2-Trichloroethane																
Trichloroethene																
1,2,3-Trichloropropane																
Trichlorofluoromethane																
Vinyl chloride																
Benzene																
Chlorobenzene																
1,2-Dichlorobenzene																
1,3-Dichlorobenzene																
1,4-Dichlorobenzene																
Ethyl benzene																
Toluene																
m,p-Xylenes																
o-Xylene																

SOIL GAS DAILY CALIBRATION STANDARD REPORT

DATE: ______________________ ______________________

SUPPLY SOURCE: ______________________ ______________________

MACHINE ID: ______________________ ______________________

COMPOUND	MASS	RT	RF	%DIFF*	MASS	RT	RF	%DIFF*
Bromobenzene								
Bromodichloromethane								
Bromoform								
Bromomethane								
Carbon tetrachloride								
Chloroethane								
Chloroform								
Chloromethane								
Dibromochloromethane								
Dibromomethane								
Dichloromethane								
1,1-Dichloroethane								
1,2-Dichloroethane								
1,1-Dichloroethene								
c-1,2-Dichloroethene								
t-1,2-Dichloroethene								
1,2-Dichloropropane								
c-1,3-Dichloropropene								
t-1,3-Dichloropropene								
1,1,1,2-Tetrachloroethane								
1,1,2,2-Tetrachloroethane								
Tetrachloroethene								
1,1,1-Trichloroethane								
1,1,2-Trichloroethane								
Trichloroethene								
1,2,3-Trichloropropane								
Trichlorofluoromethane								
Vinyl chloride								
Benzene								
Chlorobenzene								
1,2-Dichlorobenzene								
1,3-Dichlorobenzene								
1,4-Dichlorobenzene								
Ethyl benzene								
Toluene								
m,p-Xylenes								
o-Xylene								

* %DIFF = percentage difference with average Response Factor from the latest initial calibration

Site Name and Location: Sample Collected by:

Sampling Date: Sample Analysed by: Page 1 of

Smple ID	Dpth ft	Pur V ml	Vacum in Hg	Smple Time	Injct Time	Injct V ul	Compound 1		Compound 2		Compound 3		Compound 4		Compound 5		Compound 6	
							Area	ug/l	Area	ug/l	Area	ug/l	Area	ug/l	Area	ug/l	Area	ug/l

Sampling and Analytical Notes:

Site Name and Location: Sample Collected by:

Sampling Date: Sample Analysed by: Page 2 of

Smple ID	Dpth ft	Compound 7		Compound 8		Compound 9		Compound 10		Compound 11		Compound 12		Compound 13		Compound 14	
		Area	ug/l	Area	ug/l	Area	ug/l	Area	ug/l	Area	ug/l	Area	ug/l	Area	ug/l	Area	ug/l

Sampling and Analytical Notes:

SOIL GAS LABORATORY QUALITY CONTROL CHECK SAMPLES

DATE PERFORMED: ____________ ____________

INJECTION TIME: ____________ ____________

SUPPLY SOURCE: ____________ ____________

COMPOUND	TRUE CONC	DET CONC	%DIFF	TRUE CONC	DET CONC	%DIFF

DATE PERFORMED: ____________ ____________

INJECTION TIME: ____________ ____________

SUPPLY SOURCE: ____________ ____________

COMPOUND	TRUE CONC	DET CONC	%DIFF	TRUE CONC	DET CONC	%DIFF

APPENDIX B

INSTRUCTION MANUAL FOR THERMO ENVIRONMENTAL INSTRUMENTS, INC. MODEL 580B OVM/DATALOGGER (PHOTO-IONIZATION DETECTOR)

INSTRUCTION MANUAL

OVM / DATALOGGER

MODEL 580B

Thermo Environmental Instruments Inc.
8 WEST FORGE PARKWAY • FRANKLIN, MA 02038
(508) 520-0430 • TELEX: 200205 THEMO UR

580B USER MANUAL

Table of Contents

SECTION I

Introduction

The 580B is a portable Organic Vapor Meter (OVM). Which detects and quantitates most organic vapors with a highly sensitive photoionization detector (PID). The 580B has an operating range of 0-2000 parts per million (ppm) with a minimum detectable of 0.1 ppm. No support gases are required.

The 580B is controlled by a microprocessor which provides many features that were not prevoiusly available. Maximum signal hold, detector linearization, overrange lockout, IBM PC (or compatible) interface, extensive data logging capabilities and much more. With the many features provided by the 580B leak detection, head space measurements, and field survey are all easily accomplished. Completely portable, the 580B operates from internal batteries for eight hours in the field.

1.1 ABOUT THIS MANUAL

This manual is broken down into eight chapters. The first chapter (this one) provides a general overview of the 580B. Chapter two discusses, in great detail, the extensive facilities of the 580B. The focus of this chapter is on how to use the seven switches to access the various facilities. Chapter three explains, in detail, how to perform routine maintenance on the 580B. Chapter four is a technical discussion of calibration and methods for generating standards. Chapter five is a technical discussion of a few applications which illustrate some of the uses of the 580B. Chapter six is a technical discussion of methods for collecting a sample useing the 580B. Chapter seven is a discussion of the communication facilities provided by the 580B. Chapter eight contains two flow charts which illustrate the 580B software flow. This chapter is a helpful tool for the new user. Appendix A is a detailed explanation of the 580B communication protocol. This chapter is provided in order to allow a programmer to develop specialized communication software for the 580B. There are several other addendums which contain miscelaneous information about the 580B.

1.2 INSTRUMENT OVERVIEW

This section describes various points of interest on the 580B. Each number refers to a number in figure 1.1.

1. POWER PLUG - The power plug is used to run the instrument off of its internal batteries. There is a chain attached to the power plug so that it will not be lost.

2. RS-232 CONNECTOR - This connector is used for communication with a serial printer or computer. A communication cable provided with the instrument fits into the receptacle.

3. KEY PAD - There are seven switches which operate the 580B. The switch marked ON/OFF is used to turn the pump and lamp on and off. The switch marked LIGHT will turn on backlighting for the two line display. The other five switches perform various functions. For a detailed description of the function of each switch see chapter two or the flow charts in chapter eight.

4. DISPLAY - The 580B has a two line by sixteen character display.

5. SHOULDER STRAP - There is an adjustable shoulder strap for carrying the 580B.

6. SAMPLE EXIT PORT - The 580B sample is drawn into the detector by a positive displacement pump and then sent back out through the exit port.

   NOTE : The photoionization detector is a non destructive detector so the sample may be collected at the exit for further analysis (see chapter six).

7. PUMP - The 580B pump draws the sample into the detector.

8. MOUNTING SCREWS - There are four screws which hold the 580B top and bottom together. The screws are specially designed so that they do not fall out when they are loosened out of the case top.

9. DETECTOR - The photoionization detector is shown with the lamp and high voltage power supply.

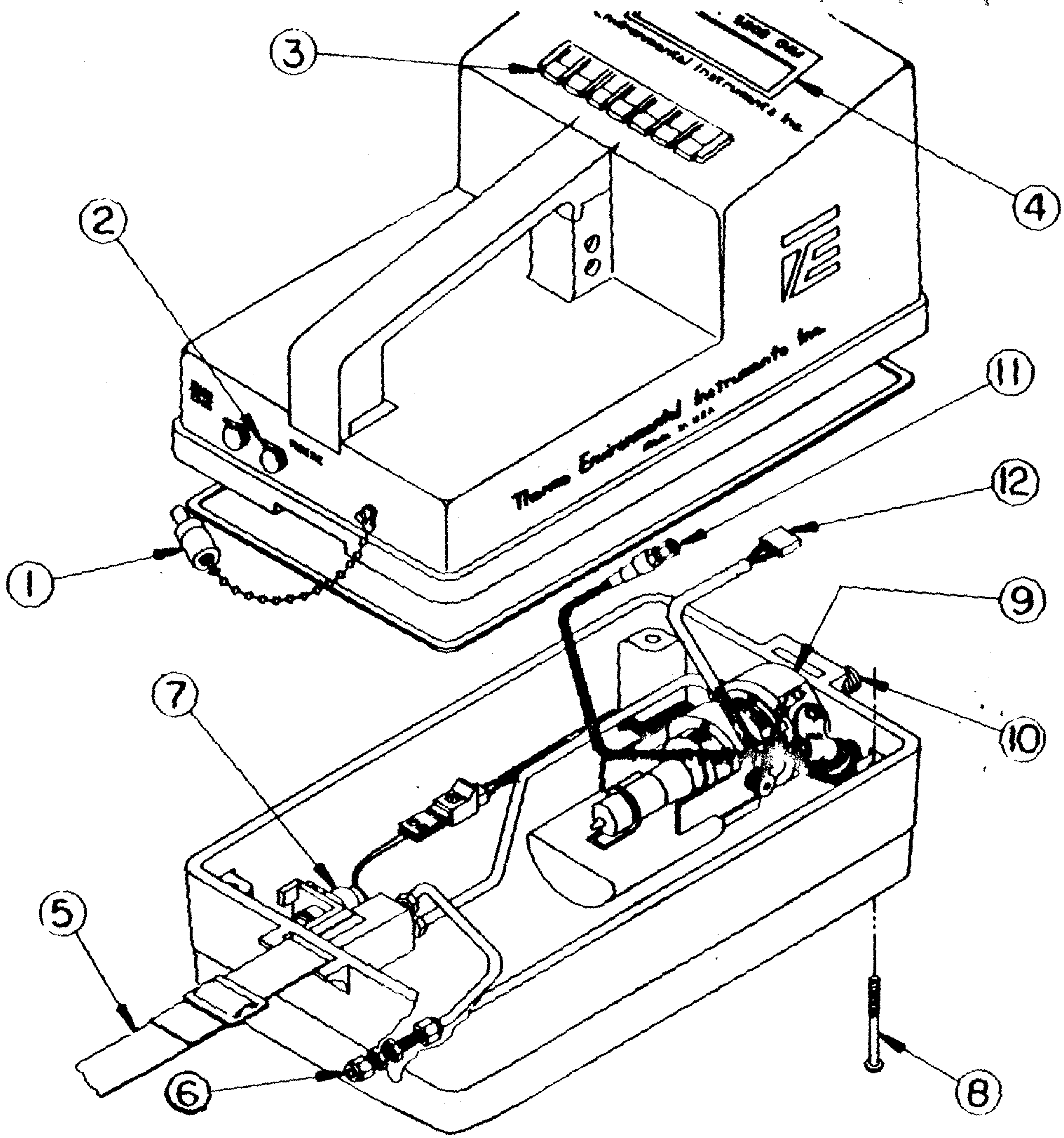


FIGURE 1.1

10. SAMPLE INLET - Sample is drawn into the detector through the sample inlet at the front of the 580B.

11. SIGNAL CABLE - The PID signal is brought up to the microprocessor, for analysis, via the coaxial signal cable.

12. BASE HARNESS - The base harness plugs into a connector on the case top.

1.3 580B FEATURES

This section provides a brief overview of the various features of the 580B. After reading this section the user should have a good idea of what the instrument can do. Chapters two and three will explain, in deatail, how each feature is selected.

TURNING ON PUMP AND LAMP - The pump and lamp are turned on by pressing the ON/OFF switch (the instrument power must allready be on).

CALIBRATION - Calibration of the 580B is extremely important. Chapter two explains how to calibrate the 580B in great detail. Chapter four discusses at length some of the basic theory and methods behind calibration. It is strongly suggested that this chapter be read in order to gain a deeper understanding of usage of the 580B. Chapter three also discusses calibration.

CONCENTRATIONS - Once the lamp and pump have been turned on the 580B begins to display the concentration of the incoming sample on the bottom line of the display. Normally the top line of the display will be a bar graph (logarithmic on a scale of zero to 2000). The operator may however select the MAX HOLD mode of operation. When in max hold, the top line of the display will show the highest concentration.

LOGGING - The 580B provides extensive facilities for logging information. The operator may save a particular reading along with a six digit location code and a date and time stamp. If the 580B is in the MAX HOLD mode when logging is initiated then the max hold value will be logged.

AUTO LOGGING - Logging may be performed automatically by using the 580B's auto logging feature. Auto logging is not allowed while in the MAX HOLD mode. When auto logging is selected a LOGGING INTERVAL is selected (anywhere from one second to 99 minutes and 59 seconds). At the end of each logging interval the present concentration will be logged (the location code is automatically incremented each time).

AVERAGE - The 580B normally updates the concentration once per second. The operator has the option of setting the averaging time anywhere from one second up to four minutes.

NOTE : The bottom line of the display will be blank until the first averaging interval is completed. The top line will however be updated each second.

RESPONSE FACTOR - A response factor may be used in order to relate a particular gas to the calibration gas. When computing the concentration the micrprocessor multiplies the concentration by the response factor and displays the result. If the response factor is one then the concentration is not changed. Chapter four and five explain some uses of the response factor.

LAMP SELECTION - The 580B allows for calibration data to be saved for one 10.0 eV lamp and one 11.8 eV lamp. A lamp serial number may also be entered. This allows lamps to be switched in the field without requiring recalibration.

ALARM - An alarm level may be selected. The 580B will sound an audible alarm (the top line will also indicate an alarm) whenever the concentration goes above the selected alarm level.

ACCESS - The 580B provides four access levels so that various features may be "locked out." User identification number and instrument number are also provided.

CLOCK - The 580B has an internal clock which will run even when the instrument power is cut off.

COMMUNICATION - The 580B has a serial communication port for outputing data to a serial printer. Many of the 580B features may be accessed from a remote computer through the serial communication port (there is communication software available which will run on an IBM PC or clone).

DISPLAY LOGGED DATA - The logged data may be displayed on the 580B's two line display.

SECTION 2

Principle of Operation

2.1 INTRODUCTION

The 580B has seven switches located just below the display. They are labeled:

ON/OFF   MODE/STORE   RESET   LIGHT   +/INC   -/CRSR   SPKR

The ON/OFF switch toggles the lamp and pump power between on and off. The MODE/STORE, RESET, +/INC, -/CRSR and SPKR switches all have various meanings (including none at all) depending upon the mode. The SPKR switch normally is used to toggle the insturment speaker between on and off. Pressing the MODE/STORE switch will cause the 580B to return to the Run mode. Except when the 580B is already in the run mode. In which case it will cause the 580B to enter the log mode.

The LIGHT switch is used to illuminate the display.

The 580B has several modes. Some of the modes may have sub modes. The modes and sub modes are tabulated below.

- Run mode
  - Concentration meter normal
  - Max hold
- Log mode
- Parameter mode
  - Calibration mode
- Access mode
- Clock mode
- Communication mode

The following sections will describe each mode and how to get to them and through them. It is strongly suggested that this section be carefully read and that the 580B be used along with the manual in order to reinforce the manual.

2.2 RUN AND LOG MODE

2.2.1 POWER FOR LAMP AND PUMP

When the 580B is first turned on (see section 1.3) the display will indicate that the lamp is not lit. Pressing the ON/OFF switch will tell the microprocessor to turn on the lamp and the pump. The microprocessor will send power to the lamp and pump and then "look" to see if the lamp actually lit. If it did not light then the microprocessor will try again. If after fourteen seconds the lamp still will not light then the microprocessor will indicate a lamp out condition.

In the event that the microprocessor is unable to light the lamp, check the seating of the lamp (see section 3.1). If the problem persists call service.

Once the lamp is lit the display will show the PPM (parts per million) on the bottom line. The top line will either be a bar graph or the maximum reading (see section 2.2.2).

To turn the the lamp and pump off simply press the ON/OFF switch.

2.2.2 RUN MODES

The 580B has two run modes, Max Hold and Concentration meter. The run mode is selected in the Parameters section (see section 2.3). In the concentration meter mode the top line of the display will be a bar graph. The bar graph is a logarithmic bar graph over the range of 0 to 2000 PPM. The bar graph is intended as a rough visual indication of the current PPM. The bottom line will indicate the exact PPM.

In the Max Hold mode the top line of the display will indicate the maximum reading. The bottom line of the display will indicate the current PPM. Whenever a new maximum is seen the top line will be updated. The Max Hold reading may be reset by pressing the RESET switch while in the run mode.

2.2.3 LOG MODE

The ability to "log" data is one of the 580B's greatest features. Readings may be stored for later analysis. Each reading will have a date and time as well as a location code associated with it. Up to over 700 readings may be stored. Logged data may even be sent to a printer or computer via an RS- 232 serial communication port (see section 2.6).

The Log mode is entered from the Run mode by pressing the MODE/STORE switch. When this switch is pressed from the Run mode the display will show:

LOG THIS VALUE?

on the top line and either PPM or MAX PPM on the bottom line depending upon which run mode the 580B is currently in. By pressing the +/INC switch the display will then show:

LOC. CODE 000001

on the top line (the actual location code may not be 000001). The location code may now be entered. By pressing the +/INC switch the number above the cursor may be incremented. By pressing the -/CRSR switch the cursor may be moved to the next digit. The 580B automatically increments the location code each time a data point is logged.

Once the desired location code has been entered pressing the MODE/STORE switch will "log" the data point. This means that the reading displayed on the bottom line along with the location code, the current date and the current time will be stored into the 580B's memory. The 580B will then return to the Run mode.

If for any reason logging is not desired, pressing the RESET switch rather than the MODE/STORE switch will cause the value not to be stored. The 580B will then go back to displaying:

LOG THIS VALUE?

Pressing the mode switch will now return the 580B to the Run mode.

2.2.3.1 AUTO LOGGING MODE

The 580B may be instructed to automatically log data according to a predefined time interval. AUTO LOGGING is selected from within the Parameters section (see section 2.3). At the end of the logging interval (setable from 1 second up to 99 minutes and 59 seconds) the current average ppm value will be logged and the logging interval will be restarted.

NOTE : Auto logging is not allowed with the Max Hold mode.

2.2.4 SPEAKER

While the 580B is in the Run mode the speaker may be turned on. The speaker will generate a "clicking" which will increase in speed as the concentration increases. The purpose of the speaker is to give to operator an audible indication of the PPM. The speaker may be turned on or off by pressing the SPKR switch. The speaker rate may also be changed by changing the switches located inside of the side door (see section 1.2). Only one of the four speaker rate switches should be on (in the down position) at any time.

2.2.5 LOW BATTERY

The 580B will display a warning when the battery is low. The warning will be a flashing B in the left hand corner of the bottom line of the display when the 580B is in the Run mode. The 580B should be recharged when the low battery warning is activated.

2.2.6 OVERRANGE

The 580B will display an overrange warning if the concentration goes above 2000 PPM. The top line of the display will show:

OVERRANGE

Once an overrange condition occurs the instrument will "lock out". This means that the overrange warning will continue to be displayed until the instrument is brought to a "clean" area. A clean area is defined to be an area where the concentration of organic vapors is below 20 PPM. The 580B will continue to indicate PPM on the bottom line during an overrange condition.

2.2.7 ALARM

The 580B has an alarm which will sound if the PPM rises above the alarm setting. The alarm setting is entered in the Parameters mode (see section 2.4.3). If the speaker is not activated then the alarm will of course not be heard. Once the PPM drops below the alarm setting the alarm will turn off. The top line of the display will also indicate when there is an alarm condition.

2.3 MAIN MENU

By pressing the MODE/STORE switch from the Run mode and then pressing the -/CRSR switch when asked if logging is desired, the 580B will display the main menu:

R/COMM -/PARAM
+/ACCESS S/CLOCK

The other four operating modes (Communication, Parameters, Access and Clock) may be entered from the Main menu. The operating mode may always be returned to by pressing the MODE/STORE switch.

2.4 PARAMETERS MODE

All of the 580B operating parameters are entered in the Parameters mode. Ths 580B is also calibrated from within the Parameters mode. The Parameters mode may be entered by pressing the -/CRSR switch from the main menu.

There are eight different sections in the parameters mode.

1. Run mode selection
2. Auto Logging selection
3. Average time selection
4. Alarm setting
5. Lamp selection
6. Response factor setting
7. Calibration
8. Free space indication

Pressing the +/INC switch will advance the 580B to the next section. Pressing the -/CRSR will advance the 580B to the previous section. Each section and any of its sub-sections will be described in the following pages. It is important to note that when the 580B is in a sub-section of any of the above sections that the +/INC and -/CRSR switches will have a different meaning. This may seem confusing at first but will become clear after stepping through each section.

2.4.1 RUN MODE SELECTION

There are two Run modes. Concentration meter normal and Max Hold (see section 2.2.2). The top line of the display will show:

CONC. METER

the bottom line will show:

"RESET" TO CHG

the bottom line will alternate every two seconds with:

MAX HOLD

if the 580B is in the Max Hold mode. Pressing the RESET switch will cause the 580B to show:

MAX HOLD
\+ = USE/ – = NO

if the + / INC switch is pressed then the Max Hold mode will be selected. If the – / CRSR switch is pressed then the Concentration meter normal mode will be selected. In either case the 580B will then return to the previous screen.

2.4.2 AUTO LOGGING SELECTION

The 580B can be configured to automatically log data points. The top line of the display will show:

AUTO LOGGING

The bottom line will alternate between "RESET TO CHG." and "ON" or "OFF". Pressing the RESET shitch will cause the 580B to show:

AUTO LOGGING
\+/ON –/OFF

Pressing the -/CRSR switch will turn auto logging off and return operation to the previous screen. Pressing the + / INC switch will enable auto logging and allow setting of the logging interval. The display will show:

INTERVAL 00:01
"RESET"WHEN DONE

The + / INC switch will increment the number above the cursor and the – / CRSR switch will move the cursor. The logging interval format is MM:SS (where M is minute and S is second). Pressing the RESET switch will return operation to the first auto logging screen.

2.4.3 AVERAGE TIME SELECTION

The 580B can be configured to display the average PPM from once a second up to once every four minutes. The display will show:

AVERAGE = 0:01
"RESET" TO CHG

Pressing the RESET switch will cause the 580B to show:

AVERAGE = 0:01
"RESET"WHEN DONE

The + / INC switch will increment the number above the cursor and the – / CRSR switch will move the cursor. The average time format is M:SS (where M is minutes and S is seconds).

NOTE : The maximum averaging interval is four minutes.

2.4.4 ALARM SETTING

The 580B will display the current alarm setting on the top line of the display. The setting may be changed by simultaneously pressing the RESET switch with either the + / INC switch to increment the digit above the cursor or the – / CRSR switch to move the cursor.

2.4.5 LAMP SELECTION

The 580B will display:

LAMP

on the top line. The bottom line will alternate every two seconds between:

"RESET" TO CHG

and the currently selected lamp setting and its associated serial number.
i.e.

11.8eV 000000

By pressing the RESET switch, the 580B will display:

+ / 10eV − / 11eV

on the bottom line. Pressing the + / INC switch will select the 10.0 eV lamp. Pressing the − / CRSR switch will select the 11.8eV lamp. In either case the 580B will then allow editing of the lamp serial number. The display will show:

SERIAL # 000000
"RESET" WHEN DONE

The + / INC switch will increment the number above the cursor and the − / CRSR switch will move the cursor. Pressing the RESET switch will return operation to the original lamp screen.

2.4.6 RESPONSE FACTOR SETTING

The current Response Factor setting will be displayed on the top line of the display. The Response Factor may be changed by simultaneously pressing the RESET switch with either the + / INC switch to increment the digit above the cursor or the − / CRSR switch to move the cursor.

The response factor is used to equate the response of one organic vapor with that of the calibration gas. The current reading is allways multiplied by the response factor in order to obtain the displayed concentration. A response factor of one will not change the displayed concentration.

2.4.7 CALIBRATION

The 580B will display:

"RESET" TO
CALIBRATE

The calibration mode may be entered by pressing the RESET switch.
The 580B will display:

RESTORE BACKUP
+ = YES

The previous calibration information may be restored by pressing the + / INC switch. The 580B will then return to the previous screen. If the backup is not desired, by pressing the − / INC switch the calibration routine will continue. The display will show:

ZERO GAS
RESET WHEN READY

Once zero gas has been introduced the RESET switch should be pressed. The 580B will then zero the instrument. The 580B will display:

MODEL 580B
ZEROING

Once the 580B has been zeroed the 580B will display:

SPAN PPM = 0000

The Span gas concentration may now be entered by simultaneously pressing the RESET switch and either the +/INC switch to increment the digit above the cursor or the −/CRSR switch to move the cursor. Once the span gas concentration has been entered the +/INC switch should be pressed.

The 580B will then display:

SPAN GAS
RESET WHEN READY

Once the span gas has been introduced the RESET switch should be pressed. The 580B will then calibrate the instrument. The 580B will display:

MODEL 580B
CALIBRATING

Once the 580B has been calibrated the 580B will go back to the beginning and display:

"RESET" TO
CALIBRATE

If during the zeroing or calibrating of the 580B a steady reading was not seen then the 580B will display:

CAL ERROR
RESET WHEN READY

Pressing the RESET switch will return the 580B to zeroing or calibrating (depending of course on which it came from).

See section 4.1 for tips on calibrating the 580B.

2.4.8 FREE SPACE INDICATION

This section will give a rough indication of how much room is left for logging data points. The screen will display a bar graph on the top line and the amount of free space on the bottom line. The number indicates the total number of bytes which are available. Each data point takes fifteen bytes. Other bytes may also be needed in order to store other important information. This is why only a rough indication of room may be given.

2.5 ACCESS MODE

The Access mode is entered by pressing the +/INC switch from the main menu. The 580B has four access levels, zero through three. Level zero will only allow the operator to log data points and of course to change access levels (only if the access code is known). Level one will also allow the user to change the user identification number. Level two will allow the user complete access to the Parameters mode, and allow viewing of the date and time. Access level three allows complete access.

The access mode has three sections:

1. Access level
2. User identification number
3. Instrument number

Pressing the +/INC switch will advance the 580B to the next section. Pressing the −/CRSR switch will advance the 580B to the previous section.

TABLE OF ACCESS LEVELS

ACCESS LEVEL	OPERATIONS ALLOWED
0	Change access level Log data
1	All above operations View time and date View communication format Display logged data Change user I.D.
2	All above operations Change operating Parameters Reset logged data
3	All operations available

2.5.1 ACCESS LEVEL

The screen will display:

ACCESS LEVEL 3
"RESET" TO CHG

By pressing the RESET switch the 580B will display:

KEY 00003
"RESET" WHEN DONE

Please note that in both screens the 3 indicates the current access level and may not nescessarily be a three.

In order to change the access level the +/INC switch may be pressed to increment the digit above the cursor and the −/CRSR switch may be pressed to move the cursor. The desired access level should be entered in the right most digit. Note that only access levels between zero and three are legal. The remaining four digits are the access code. The access code will be 0000 when the instrument is shipped. The access code should then be entered. Once this is done press the RESET switch. The 580B will then return to the previous screen.

If the access code entered was not the proper access code, or if the access level was not a legal access level then the access level will not be changed.

The last and most important point regarding the access level is how to change the access code. The access code is the four rightmost digits of the instrument number. The instrument number is only viewable (and therefore only changable) while in access level three.

2.5.2 USER IDENTIFICATION NUMBER

The screen will display:

I.D. # 014563977
"RESET" TO CHG

By pressing the RESET switch the 580B will display:

I.D. # 014563977
"RESET" WHEN DONE

The user identification number may be changed by pressing the +/INC switch to increment the digit above the cursor and the −/CRSR switch to move the cursor. The user identification number is a nine digit number (just right for fitting a social security number). Once the user identification number has been entered press the RESET switch and the 580B will return to the previous screen.

2.5.3 INSTRUMENT NUMBER

The screen will display:

INSTR # 000000
"RESET" TO CHG

By pressing the RESET switch the 580B will display:

INSTR # 000000
"RESET" WHEN DONE

The instrument number may be changed by pressing the +/INC switch to increment the digit above the cursor and the −/CRSR switch to move the cursor. Once the instrument number has been entered the RESET switch should be pressed. The 580B will then display the previous screen.

When the instrument number is changed it is very important that the last four digits be remembered. These digits are the access code and therefore will need to be known in order to change the access level.

2.6 CLOCK MODE

The Clock mode is entered from the Main menu by pressing the SPKR switch. The screen will display the date and time on the top line. The bottom line will display:

"RESET" TO CHG

By pressing the RESET switch the 580B will display:

"RESET" WHEN DONE

The date and time may be changed by pressing the +/INC switch to increment the number (or in the case of the month the months abreviation) above the cursor. The −/CRSR switch will move the cursor. Once the proper month has been entered the RESET switch should be pressed. The 580B will return to the previous screen.

The date and time will be maintained even when the instrument is turned off! It is however advisable that the date and time periodically be checked to ensure that it is correct.

2.7 COMMUNICATION MODE

The Communication mode is entered from the main menu by pressing the RESET switch. The Communications mode has four sections.

1. Communicate with printer or computer
2. Display logged data
3. Reset logged data
4. Set communication parameters

Pressing the −/CRSR switch will advance the 580B to the next section.

NOTE : A detailed discussion of communication protocol is given in appendix A. Further discussion of communication may be found in chapter seven.

2.7.1 COMMUNICATE WITH PRINTER OR COMPUTER

The 580B is capable of communicating with a computer or outputing logged data to a printer. The 580B will display:

COMMUNICATE?
"+" = YES

if the computer format is selected or it will display:

OUTPUT TO PRINTER
"+" = YES

if the printer format is selected. In either case pressing the +/INC switch will cause the 580B to try to establish communication. Pressing the −/CRSR switch instead will cause the 580B to advance to the next section.

2.7.2 DISPLAY LOGGED DATA

If at least one data point has been logged the 580B will display:

DISP. LOG DATA?
"+" = YES

By pressing the +/INC switch the 580B will display the first data point. The date and time which the data point was logged will be displayed on the top line. The bottom line will alternate between the location code and the PPM. Pressing the +/INC switch will advance to the next logged data point. This will continue until there are no more data points at which time the 580B will display:

NO DATA STORED

The MODE/STORE switch may be pressed to return to the Run mode.

2.7.3 RESET LOGGED DATA

The logged data can be erased so that more data points may be logged. The screen will display:

RESET LOG DATA?
"+" = YES

Pressing the +/INC switch will erase all of the logged data points. The 580B will then advance to the next section.

2.7.4 COMMUNICATIONS PARAMETERS

The 580B can be configured to communicate with a printer or a computer. The baud rate may also be set for 9600, 4800, 2400, 1200, 900, 600, 300, or 150 baud. The 580B will display the current communication format (computer or printer) on the top line and the current baud rate on the bottom line. Pressing the RESET switch will cause the 580B to display:

COMPUTER FORMAT
+ = USE − = NO

Pressing the +/INC switch will select the computer format and the 580B will advance to the baud rate screen (see below). Pressing the −/CRSR switch will cause the 580B to display:

PRINTER FORMAT
+ = USE − = NO

Pressing the + / INC switch will select the printer format and the 580B will advance to the baud rate screen (see below). Pressing the – / CRSR switch will cause the 580B to display the previous screen.

The baud rate screen will display the currently selected baud rate on the top line. The bottom line will display:

+ = USE – = NO

Pressing the + / INC switch will cause the displayed baud rate to be selected and the 580B to show the selected format on the top line and the baud rate on the bottom line. Pressing the – / CRSR switch instead will cause the next lowest baud rate to be displayed.

2.8 BATTERY / CHARGER

The model 580B uses a 1.2 amp hour lead acid (gel cell) battery. There is protection circuitry potted directly on top of the battery. The battery is rechargable with the charger provided with the instrument.

The charger is regulated so that there is no danger of "over charging" the battery. The charger has an LED which indicates when the battery is being charged. The LED's brightness is proportional to the current being delivered into the battery.

SECTION III

Routine Maintenance

The routine maintenance of the 580B involves the calibration of the instrument, the cleaning of the lamp window, and the maintaining of charge on the battery. The following pages give instructions for routine maintenace. Figure 3.1 illustrates the detector assembly.

3.1 LAMP INSERTION AND REMOVAL

3.1.1 REMOVAL

NOTE: The 580B must be off while removing the lamp.

In order to remove the lamp the four screws which hold the case top and bottom together must first be loosened. The case bottom should be placed flat on the table and the top placed on its side next to the bottom.

The high voltage power supply is removed next by loosening the thumb screws on each side and then pulling the power supply towards the rear of the instrument (see figure 3.1). The lamp may now be removed by loosening the lamp nut.

3.1.2 INSERTION

Insertion of the lamp is accomplished by performing the above tasks in the reverse order. The lamp should be placed flat against the o-ring and the lamp nut fastened down in order to create a proper seal. The high voltage power supply should then be inserted and the thumb nuts fastened down. There are three pins protruding from the high voltage power supply which should fit snugly into connectors located beneath the detector. The lamp spring (mounted in the center of the high voltage power supply) should make contact with the lamp ring.

3.1.3 LAMP CLEANING

On occasion the lamp should be removed for cleaning. Cleaning of the lamp is accomplished by cleaning the lens surface of the UV lamp. This is accomplished by using the aluminum oxide scouring powder provided with the 580B.

The procedure for cleaning the lamp is as follows. First place a small amount of aluminum oxide scouring powder on the lens of the UV lamp. Next gently scour this lens with a soft tissue or cloth. Scour the lens in a rotary type motion. After scouring the lens surface gently blow the remaining powder from the lens. Throughly wipe the lamp lens with a clean tissue to remove the last traces of cleaning powder. The lamp is now able to be inserted into the detctor.

3.2 CALIBRATION

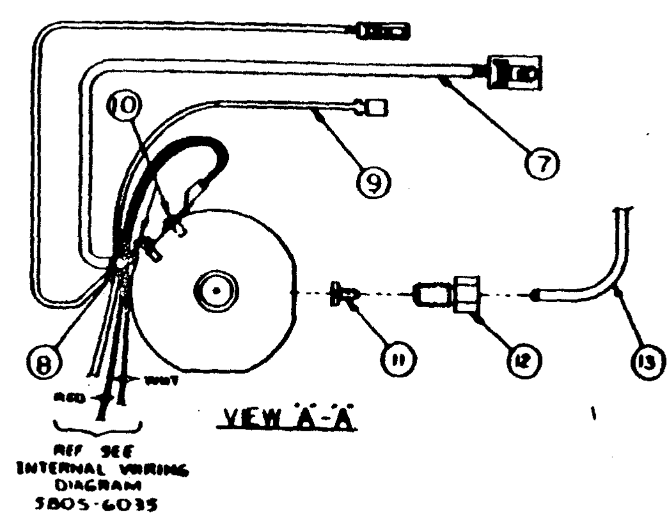
NOTE : Chapter four should be read before calibrating the 580B in order to gain a better understanding of the concepts behind calibration of the 580B.

The following is a brief discussion of calibration as it relates to different lamps. One of the parameters in the Parameters mode (see section 2.3) allows selection of lamp setting. The two types of lamps are the 10.0 eV and the 11.8 eV lamp. Whenever a new lamp is used the 580B must be calibrated. This is true even if the new lamp is the same type. For example the new and old lamp are both 10.0 eV. This is due to the fact that each lamp will have a slightly different sensitivity.

It is important to note that the 11.8 eV lamp will in general be less sensitive than the 10.0 eV lamp. This is true despite the higher energy level of the 11.8 eV lamp. The 11.8 eV lamp will however "see" certain gases which the 10.0 eV lamp will not. See table E.1 for a list of common organic vapors and their associated ionization potentials. Any questions regarding the use of the 580B should be directed to Thermo Environmental's Application Laboratory.

The 580B is quite simple to calibrate. A source of "zero air" and "span gas" are all that is needed to calibrate the 580B.

BILL OF MAT'L			
ITEM	PART NO.	DESCRIPTION	QTY.
1	580B-6003	DETECTOR SUB ASSY.	1
2	580S-2010	NUT-LAMP (13507)	1
3	580S-6019	PWR. SUPPLY ASSY. (13560)	1
4	12082	NUT-KNURLED	2
5	2140-0014	U.V. LAMP 10.0	1
6	580S-6035	DETECTOR WIRING ASSY. (13575)	1
7	580B-6001	BASE HARNESS ASSY.	1
8	4166	STRAIN RELIEF	1
9	580S-6028	SIGNAL CABLE (13568)	1
10	5814	4-40 1/4'' BINDER HD. SCREW	2
11	4629	INSERT	1
12	10140	DELRIN FITTING	1
13	5510	TEFLON-TUBING - 1/8" (APPROX. 8" LG)	1



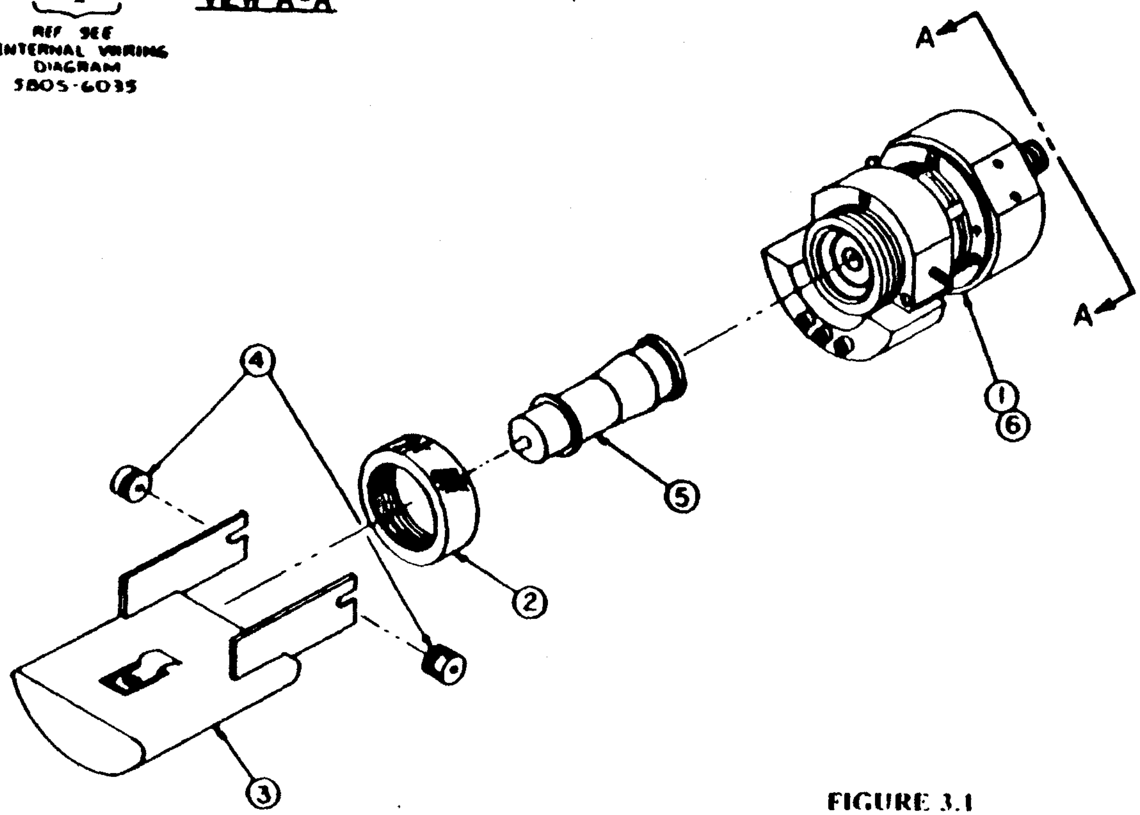


FIGURE 3.1

TITLE
DETECTOR
ASSY.

SIZE C
DRAWING NUMBER 580B 600
REV.

The zero air is introduced to the 580B in order to determine the "background" signal. The concentration of the span gas is then selected. The span gas is finally introduced to the 580B. The instrument makes all of the necessary calculations (including linearization) to arrive at a "calibration constant." When in the Run mode the signal is multiplied by the calibration constant in order to arrive at the current PPM.

$$\text{CALIBRATION CONSTANT} = \frac{\text{SPAN PPM}}{\text{SPAN ZERO SIGNAL}}$$

$$\text{PPM} = (\text{SPAN SIGNAL} - \text{ZERO SIGNAL})\ \text{CALIBRATION CONSTANT}$$

NOTE : The PPM is then multiplied by the RESPONSE FACTOR before being displayed. Chapter four explains the use of response factors when calibrating.

Section 2.4.6 gives a detailed explanation of which buttons to press in order to calibrate the 580B. The flow chart at the back of this manual may also be helpfull.

3.3 CHARGE

When there is a flashing "B" in the lower left corner of the display (while in the run mode) the battery is low. The battery is recharged by pluging the charger into the RUN/CHARGE plug at the rear of the 580B. The instrument runs while it is charging. The charger has an LED which indicates the amount of current being drawn. The LED gets brighter as more current is drawn. The LED can therefore be used as a rough indication of the charge on the battery.

SECTION IV
Calibration

4-1 GENERAL

The Model 580B Organic Vapor Meter is indeed a quantitative instrument and can certainly be used as such. It makes use of the Photoionization Detection System using a lamp with an ionization energy of 10.0 eV which is standard in the Model 580B. Almost all organic materials will be ionized at this energy level. There are some organic materials, such as a few of the freons, methane, ethane and propane that are not ionized and thus will not be detected. The ionization potentials for the various organic materials will simply tell whether the material will be detected by the Photoionization Detector. It does not give any clue as to the sensitivity of that detector for that particular material. Certainly, different organic vapors will have different sensitivities. It is important to understand that the Model 580B does indeed sense most organic vapors and that its response to these different organic vapors will indeed be different.

In this section of the manual, the aspects of calibrating the Model 580B for various vapors will be discusssed. In the following section discussing applications, various ways of using the features of the Model 580B will be explained along with the various methods for calibration of the 580B. There will also be applications of the Model 580B in specific instances where the organic vapors or the mixtures of organic vapors are completely unknown. The 580B can be an extremely useful tool, even in areas such as those.

FACTORY CALIBRATION OF THE MODEL 580B

To complete testing and operation in the checkout area, each Model 580B has been calibrated and linearity checked at the factory. The particular gas chosen for this calibration is isobutylene. The Model 580B has good response for isobutylene. Isobutylene standards prepared in air are relatively stable with time, undergoing no serious adsorption or reaction problems.

4-2 METHODS OF GENERATING CONCENTRATIONS OF VARIOUS MATERIALS IN AIR.

This section is not intended to be exhaustive as far as the preparation of gas and vapor standards in air are concerned. Only those methods that have been found most practical for the calibration of the 580B are discussed here. There are basically two types of standards. Static standards in which a known volume of the gas or vapor is mixed with a known volume of air and the concentration of the gas or vapor in air calculated from knowing these volumes. The second method used is what is called a dynamic standard. Dynamic standard preparation involves mixing gases or vapors with air under a flowing condition whereby the flow rate of both gases are known prior to their mixing. The concentration then is calculated from flow rates.

Certainly commercially available standard cylinders of gaseous materials in air offer the most convenient method of calibration. However, these are static standards. Standards prepared in this fashion in air for vapors of various organic liquids often show concentration reduction with time due to adsorption problems. In general, gases when mixed with air will maintain their concentrations with time since adsorption is generally not a problem. However, some gases are sufficiently reactive that chemical reaction of the gas will cause a reduction of it in air. These precautions must be observed when using commerically prepared standards for calibration of the Model 580B. It is for this reason that isobutylene in air was chosen as a reference standard for factory calibration. Static standards can be prepared in a laboratory and in general are reasonable ways of calibrating the Model 580B. However, it is important that these standards be used shortly after their preparation to reduce the significance of any adsorption problems. Static standards prepared for calibration of the Model 580B are best prepared in collapsible plastic bags. This is opposed to a fixed volume container. The sampling rate of the 580B, which is 500 ml/min, requires an appreciable amount of sample. Even one minute's sampling out of a fixed container will remove 500 ml/min from it. This should not significantly reduce the pressure inside the container. Thus, the collapsible bag provides the best means as opposed to a fixed volume. A 5 gallon polyethylene bag is a convenient size to use for the preparation of static standard.

A tube is inserted into the opened end of the bag and the bag opening then sealed around the tube. The tube should have a cutoff valve or some means of closing the volume of the bag. The volume of air introduced into the bag must be measured. This is most conveniently measured by a wet test meter. However, a source of air flowing through a flow meter can be used if the flow can be held constant, then time is a measure of the volume of the air placed into the bag. All air is expelled from the bag by completely collapsing it prior to connection to the source of air. It can then be connected to a wet test meter flow meter via a short length of rubber tubing hooked to the plastic tube of the bag. The air flow is started into the bag a rate of approximately 5 l/min. A total of 10 liters is a convenient volume for a 5 gallon bag. This would mean approximate 2 minutes for filling the bag.

For gaseous samples, the trace organic will be added via a glass hypodermic syringe. The 1 cc Tuberculin syringe is convenient size. For an isobutylene standard, the 1 cc syringe is flushed with pure isobutylene and then filled to the 1 cc mar While the air is flowing into the plastic bag, the short piece of rubber tubing is pierced by the needle from the 1 cc syrin and the plunger slowly depressed such that the 1 cc of isobutylene is added to the air flowing into the plastic bag. When liters of air have been added to the plastic bag, the flow is immediately stopped and the valve on the tube or the closing clam is applied to contain the air and isobutylene within the plastic bag. It is best at this stage of the procedure not to rely sole on the diffusion of isobutylene to form a uniform mixture inside the plastic bag. Slight kneeding of the plastic bag will haste the mixing of the isobutylene in air. The plastic tube from the bag is then connected to the probe on the Model 580B vi a short length of rubber tubing and the valve on the plastic tube immediately opened. The Model 580B withdraws a sampl from the bag at the sampling rate of 500 ml/min. Thus, 10 liters of sample in the bag will provide approximately 20 minutes Certainly the calibration of the 580B can be accomlished in a shorter period of time. The concentration of isobutylene in ppm by volume will be equal to the sample size, which was 1 cc, divided by the volume of the bag in liters, which would be 10 liters, times 1000. In this particular instance, the concentration would be:

$$\text{Conc (ppm by Vol)} = \frac{\text{1cc Isobutylene} \times 1000}{\text{10 L Air}} = 100 \text{ ppm}$$

For organic materials, which are normally liquids at room temperature, the procedure is essentially the same except that an extremely small liquid sample is injected into the flowing air stream rather than the gas sample. This technique works well only for relatively volatile organic materials. The flowing air stream must vaporize all of the material or the calculation will be off. If the material is not rapidly volatile in that flowing air stream, the liquid should be injected through the surface of the plastic bag. Immediately after withdrawing the needle, the hole in the plastic bag should be covered with a piece of plastic tape.

Again significant kneeding of the bag will hasten the evaporation of the sample and mixing of the vapor into the air to provide homgeneous samples. The introduction of this sample into the 580B is the same as before. The calculation of the concentration of the vapor in air is a two-step procedure whereby the small volume of liquid injected into the air stream of into the plastic bag is converted to a volume of vapor. This volume of vapor is then used in the same manner as the volume of gas in the case of isobutylene. The following equations apply:

$$\text{Volume Vapor (ul)} = \frac{\text{Liquid Volume (ul)} \times \text{Liquid Density} \times 24.45}{\text{Molecular Weight}}$$

The above equation gives the vapor volume at atmospheric pressure (760 torr) and 25 C (77 F).

Then:

$$\text{Concentration (ppm by Volume)} = \frac{\text{Vapor Volume (ul)} \times 1000}{\text{Air Volume (liters)}}$$

The following is a sample calculation for benzene.

Liquid Volume = 2 ul

Benzene Density = 0.879 g/cc

Molecular Weight Benzene = 78.1

Air Volume = 10 liters

$$\text{Vapor Volume} = \frac{2 \times 0.879 \times 24.45}{78.1} = 0.55 \text{ ul} \quad \text{Benzene Vapor}$$

$$\text{Conc} = \frac{0.55 \times 1000}{10} = 55 \text{ ppm (vol)}$$

The syringe used for the measurement of liquids in this particular instance is a small volume-type such as those manufactured by the Hamilton Company. A convenient size syringe is the 10 microliter volume.

Dymanic standards can be prepared of both gases and vapors by using the techniques of either permeation tubes for gases or diffusion tubes for vapors. These permeation or diffusion devices supply a very small flow of either the gas or vapor. This is mixed with a known flow rate of air providing a flowing stream that has a known amount of either gas or vapor in the air stream. These are probably the most reliable and accurate standards available for low level concentration of gases and vapors in air. However, the techniques require some additional instrumentation in order to implement the use of these devices. The reader is referred to Thermo Environmentals applications notebook for the use of these techniques in the dymanic generation of standards.

SECTION V
Applications

5-1 GENERAL

This section discusses six applications which were done on the old model 580. These applications are discussed as they relate to the model 580B. The following applications of the Model 580B are given to show some different uses and means of calibration of the Model 580B in various practical applications. It is certainly not intended to be an exhaustive list of the uses of the Model 580B. In each situation, the stress is placed on the means of calibration and the interpretation of the readout of the Model 580B. Since the Photoionization Detector responds to virtually all organic materials and since its responce varies for the different organic materials, questions can certainly arise as to just how the numbers presented on the digital display relate to anything meaningful. These applications will hopefully illustrate several ways in which these numbers can be quantitative and also illustrate uses of the 580B where accurate quantitation may be impossible.

5-2 VINYL CHLORIDE MONOMER IN REACTION VESSELS.

This particular application involved measuring the vinyl chloride content in vinyl chloride polymerization vessels following the polymerization reaction and the removal of the polymer slurry. Any residual vinyl chloride left in the reaction vessel has to be flushed and scrubbed prior to the opening of the vessel. The vinyl chloride content must be below a certain prescribed level prior to this opening. The reactionvessel is flushed with nitrogen to remove the vinyl chloride from the vessel and purge it through the filter media which remove the vinyl chloride from the nitrogen stream for recovery. During this particular operation, it is known that vinyl chloride monomer comprises significantly more than 90% of the entire organic material. In this instance, if the Model 580B is calibrated for vinyl chloride measurement, indeed the readout will be virtually the true vinyl chloride concentration inside the reactor vessel. The nitrogen exit stream prior to the vinyl chloride recovery was the point used for the analysis.

Since the plant was a considerable distance from the laboratory and since the study would require a significant period of time encompassing several weeks, it was decided to calibrate the Model 580B with the isobutylene reference standard and determine a response factor setting for a vinyl chloride standard in the laboratory. With the response factor set at 1.0, the instrument was calibrated with isobutylene. The Model 580B was then presented with a known concentration of vinyl chloride monomer in nitrogen. The response factor for the vinyl chloride was then set in order for the Model 580B to read the correct concentration of vinyl chloride in the nitrogen. Static standards of vinyl chloride are very definitely not stable with time due to the reaction of the vinyl chloride with itself. Thus, standards need to be prepared fresh each time vinyl chloride is to be used to calibrate an instrument. Since bag preparation, which was the technique used for this laboratory calibration of the 580B, would have been impractical at the plant; the use of a stable reference standard of isobutylene was chosen. Thus, at the plant site, the Model 580B could be calibrated using the isobutylene standard from a cylinder. This of course, greatly simplified the plant use of the Model 580B. This relationship to a reference standard reduces the time and equipment required at the plant such that the survey of all of the reactor vessels was completed in a short period of time with the items established for the nitrogen flush of the reactor vessels prior to opening the reactor vessels.

5-3 MONITORING ISOLATED PLANT AREAS FOR TOLUENE AND METHYL ISOBUTYL KETONE.

Two areas of an extensive plant operation were required to be monitored for the levels of methyl isobutyl ketone and toluene. Both of these areas were relatively isolated. In one area, methyl isobutyl ketone was the only solvent to which the atmosphere was exposed other than the potential leaks that might occur in process equipment in that same area. There were no other known solvents in use in that area and the ventilating system in effect isolated this area from other areas in the plant. In the second area, toluene had just very recently been substituted as a solvent in place of benzene due to the lower TLV for benzene. Average workplace levels were therefore needed for the toluene concentration in this work area. Again, toluene was the only sclvent in this area and there was no other process equipment in the immediate area for even possible leak problems.

Notice that in both of these areas in the plant, it is certainly known from the processes occuring in that area and its relative isolation from the other areas in the plant, exactly which organic vapors will be by far the predominant vapors in the workplace air. In many instances, by simply knowing the processes involved and the chemicals in use in those processes, the qualitati aspects of the environment can indeed be established without the use of instrumentation. This is one of the most overlooke aspects in establishing what organic vapors are present in the environment. It simply involves determining what are the possib organic vapors that can be present. In general, this narrows it to several and in many cases, a single organic vapor.

In these cases, the Model 580B can be calibrated specifically for these materials and will provide quantitative data c the levels of these materials in the workplace environment. in this particular instance, even though the laboratory to be use for the calibration of the Model 580B was at the plant site, it was desired to use a single 580B to monitor both work are sequentially and several times throughout the course of a single day. This was to be done over a period of time to establis the variations of both methyl isobutyl ketone and the toluene in these work areas. In this particular instance, changing th response factor setting can avoid considerable calibration changes, as one moves from determining concentrations of mth isobutyl ketone to the area where one is measuring the concentrations of the toluene vapor.

For calibration, the Model 580B response factor was set at 1.0 and the instrument spanned properly using a known referenc standard of isobutylene. The Model 580B was then presented with a flowing air stream containing toluene vapor as generate in the Thermo Electron Model 360 using a toluene diffusion tube. The response factor was then adjusted so that the readou of the Model 580B corresponded to the toluene concentration in this standard.

The Model 580B was then presented with a flowing air stream containing methyl isobutyl ketone. This also was generate via a diffusion tube in the Model 360 Standards Generator. Once again, the response factor was adjusted so that the digita display gave the correct reading for the concentration for the methyl isobutyl ketone presented to the instrument.

With the instrument then calibrated with the reference isobutylene standard and knowing the proper settings of the respons factors for methyl isobutyl ketone and toluene, the Model 580B was then ready for its plant survey. The area containing th toluene was monitored for a period of time with the toluene levels as noted by the 580B being recorded. The response facto was set for this toluene reading. The instrument was then moved directly to the methyl isobutyl ketone area and the respons factor adjusted to read methyl isobutyl ketone. The 580B was then able to read directly the methyl isobutyl ketone concentration in the second area. There was the possibility of leaks in process equipment in this particular area. The area in genera was surveyed. If significant changes in the reading of the 580B were observed, the 580B was used as a leak sourcing instrumen as described in a later section. In this fashion, it could be determined if some of the varying concentrations in this area were indeed coming from a leak in the process equipment. During the survey of this particular area, no leaks from process equipment were observed, therefore, the readings obtained on the 580B could indeed be considered the methyl isobutyl ketone concentration in this particular area.

Throughout the survey of these two workplaces, the 580B could move back and forth rapidly due to its portability and could be, in effect, recalibrated for each of the two different vapors by the mere setting of the response factor.

5-4 PETROLEUM ETHER VAPORS IN WORKSPACE AIR.

A given workplace was using petroleum ether as a paint solvent and for cleaning purposes. It was desired to quantitate the amount of petroleum ether in the air being recirculated in this particular area. Petroleum ether is a distillation fraction from crude oil. Its boiling point is slightly lower than the boiling point of gasoline. This means that petroleum ether is not a single chemical entity, but a multitude of hydrocarbons in a certain boiling range fraction. Reasonable quantitative data can be obtained here without knowing the exact chemical composition of each hydrocarbon that composes petroleum ether. For this purpose, the Model 580B can be used to measure these vapors. The 580B is initially calibrated with the response factor set at 1.0 using a reference standard of isobutylene.

The 580B is calibrated on isobutylene. Then a bag sample is prepared, as detailed above, for the quantitation of the instrument to measure the petroleum ether. In this particular instance, the petroleum ether is injected into the bag in the same fashion that liquid samples are injected. The calculation, however, has to change slightly because the ppm on a volume basis canno be calculated without knowing the exact chemical composition of the petroleum ether. However, in a situation such as this, one can still quantitate it on a weight basis of the solvent in air. The equations below show this calculation.

$$\text{Weight Vapor (mg)} = \text{Liquid Volume (uL)} \times \text{Density g/mL}$$

$$\text{Conc (mg/m3)} = \frac{\text{Weight Vapor (mg} \times 1000)}{\text{Air Volume (liters)}}$$

For Petroleum Ether In This Example:

$$\text{Liquid Volume} = 3 \text{ uL}$$

$$\text{Petroleum Ether Density} = 0.66 \text{ g/mL}$$

$$\text{Air Volume} = 10 \text{ liters}$$

$$\text{Vapor Weight} = 3 \text{ uL} \times 0.66 \text{ g/mL} = 1.98 \text{ mg}$$

$$\text{Conc} = \frac{1.98 \times 1000}{10} = 198 \text{ mg/m3}$$

This sample in the bag is then presented to the Model 580B and the response factor adjusted so that the digital readout on the front panel provides the proper reading in mg/m3. The setting of the response factor that is needed for this reading is noted. The Model 580B can now be used to monitor reasonably quantitatively the petroleum ether in the workplace environment. Any further calibration of the instrument can be done using the reference standard of isobutylene. This is a reasonably accurate way of giving quantitative information on the amount of solvent in air even though the results are not reported in ppm on a volume basis.

This technique can be used in general when the solvents are a mixture of materials which in general will probably be petroleum distillation fractions. It would certainly also be used in the case of gasoline vapors in air. Notice from the equations used versus the equations for determining the ppm concentration in bag samples for pure liquids, the only real thing missing is the molecular weight of the material. It may be possible to assume an average molecular weight of the solvent mixture and actually report a ppm by volume basis.

5-5 LEAK SOURCING

In this particular instance, the Model 580B is to be used for determining the prescence, or absence of leaks in a chemical process plant. The Model 580B is uniquely adapted to this particular operation due to its light weight. In this particular instance, it is not necessary to accurately attempt to quantitate the readings from the Model 580B. It will be used simply to determine presence of leaks and to locate these leaks.

The Model 580B is simply calibrated against a reference standard of isobutylene as normal. No further calibration is used. It is not necessary to know the particular chemicals flowing in the different pipes or what they are in the various reaction chambers. It is only necessary to know that these materials will have some response on the Photoionization Detector. That is, that their ionization potentials are below the energy of the lamp. The standard probe of the Model 580B, with the 580B fully operational, is then simply moved along the various pipes and reactor vessels in the chemical process.

All seals are traced clear around the seal with the end of the probe. As one approaches a leak, the concentration of the organic materials in the air being sampled by the Model 580B will increase significantly. The point of maximum reading will indicate the point of the leaks. As one moves further away from the leak, the concentration of the organics in air will certainly decrease. In this very rapid fashion, the presence of leaks can be detected and their source fairly accurately pinpointed so that the leak can be repaired.

In many instances, it is not necessarily the workplace hazards of these leaks that is important, but the economics of the chemical process itself. In this instance, as in many instances, the exact composition of the organic materials being measured is really unimportant to the successful use of the 580B in a specific application. Also the exact numbers that are displayed on the digital readout of the 580B are unimportant. It is only relative magnitudes that are important in this instance.

5-6 AFTERBURNER EFFICIENCY

In a particular coating process, the material, after it has been coated, is passed into a dryer where the solvents of the coating are removed. These solvents are then vented into a stack. To reduce the hydrocarbon emmission from this plant, an afterburner had been installed to combust the organic solvents from the coating prior to release to the atmosphere. It is important to determine the efficiency of this afterburner and to follow the efficiency of the afterburner to avoid dumping excess solvent into the atmosphere and, thus, become subject to pollution fines.

The Model 580B is ideally suited to this type of operation. Again, it will be unnecessary to know the exact chemical composition of the coating solvent. The Model 580B is simply standardized against the reference standard isobutylene in the usual fashion. The Model 580B is then connected to sample the stack gas in the dryer prior to the afterburner, noting the steady state number displayed on the digital panel meter. The 580B is then connected to the exhaust gases from the stack following the afterburner. Again, the steady state number, as displayed on the Model 580B, is noted.

The reading prior to the burner minus the reading after the burner divided by the reading prior to the burner times 100 gives efficiency of the afterburner in the stack. This number is quite accurate, even though the Model 580B was not calibrated specifically for the solvents or solvent mixture used in this particular coating operation. The individual readings before and after the afterburner may not have the exact quantitative relationship to the actual amount of material, but their ratio will be accurate since basically the same chemical or mixture of chemicals is being measured before and after the afterburner.

5-7 SAMPLE COLLECTION OF UNKNOWN ENVIRONMENTS

The Model 580B can also be used in areas where organics are known to be present, but perhaps the exact composition of the environment is not known. This may be due to several solvents being in the same general workplace or various separate processes occuring in that same workplace, all of which could and possibly are admitting organic vapors. In plant areas such as these, the Model 580B can still be extremely useful.

The 580B is calibrated against a reference standard of isobutylene, as mentioned above. The 580B is then used as a survey tool throughout the entire plant area. The readings are logged, especially changes in these readings. The exact numbers displayed will not, in general, be a quantitative measure of the ppm of the organic vapor since it is impossible to know what organic chemical or mixture of chemicals should be used for the calibration. When high readings are obtained on the Model 580B, an evacuated sample bag can be connected to the rear of the 580B at the sample exhaust port. This bag could be virtually identical to the type of bag used for standards preparation. The Model 580B is sampling the atmosphere at the rate of 500 mL/min. The detection system of Photoionization is a nondestructive system such that the sample that is exiting the Model 580B is indeed the same material that is giving the readings on the 580B. When the 580B is seeing high readings, this is the time the bag is connected to the rear for sample collection. The bag, if the same type is used for sample preparation, can hold approximately 10 liters of air sample; which would permit a sampling time of 20 minutes. This bag sample can then be closed on removal from the 580B and transported to a laboratory for subsequent analysis to identify the individual chemical compounds present in the sample causing the high readings and to ascertain if the workplace environment is harmful at those high readings.

The use of the Model 580B coupled with the bag collection ensures that the sample that is returned to the laboratory for analysis is a sample containing the desired organic vapors. This is assured because the bag collection is used only when the Model 580B is detecting high levels of organic vapor in the environment. This is an instance of the use of the Model 580B when the type of organic vapors are not known and it is desired to know them. The 580B has a very useful function even in these areas. It should be noted that a charcoal tube could be connected to the rear of the 580B as well as an evacuated plastic bag. The charcoal tube will pass the bulk of the sample, which is air, and adsorb the organic vapors. This charcoal tube can be returned to the lab for subsequent analysis for both a qualitative identitification of the materials present as well as a quantitative measure of their levels.

SECTION VI
Collection Techniques

6-1 GENERAL

As mentioned in the Application Section, it is possible to use the 580B in completely unknown areas as far as the organic vapors present are concerned and still obtain meaningful data. One of the techniques described here is the use of the 580B as a means of collecting the representative samples for further identification in the laboratory regarding the specific organics that may be present in addition to their concentrations.

Two techniques were mentioned in the section under the heading "Sample Collection of Unknown Environments". One of these techniques involves the use of a bag for collection and the other involves the use of charcoal tubes as a means of trapping organic vapors. In this section, each of these techniques will be explored in further depth as to the proper way of using the 580B to collect the samples for subsequent analysis. These collection techniques are quite useful when one is using the Model 580B simply as a survey instrument. When readings on the 580B become quite high in certain areas it is impossible to determine the exact source of the high readings to perhaps pinpoint the specific organic chemical giving rise to the reading, one may very well want to identify what the chemical or chemical mixture is that is providing the high reading. This will have to be done with instrumentation significantly more sophisticated than the Model 580B; namely, an instrument that can provide specificity as well as qualitative identification. A Gas Chromatograph is such an instrument.

If it is desired to collect some of the air to send to a laboratory for further analysis, one needs to be sure that the proper samples are taken at the proper time. This means simply that one needs to be assured that the sample sent to the laboratory is indeed a sample that has a high concentration of organic vapor present in the sample. The 580B is used to indicate the presence of the high level organic vapors. The sample then is gathered at the exit port of the 580B when the 580B is reading high values. This assures that the sample sent to the laboratory does indeed have the high level vapors present in it. This generally simplifies the sampling technique of the environment and reduces the number if samples and, therefore, the expense needed to accurately identify the organics present and to quantitate them in a laboratory.

Two design features of the Model 580B make this type of operation possible. The first is that the detection system used in the Model 580B is the Photoionization Detector which is basiccally a nondestructive detector. Thus, the instrument is able to sense the organic vapor using the detector and virtually the same concentration of the same materials exits the detector as entered it. This does make it possible for the collection of the exact sample contributing to the high readings.

The second feature of the 580B that allows this sample collection is that a positive displacement pumping system is used to draw the sample into the Model 580B. It is a very simple procedure then to attach to the exit of this positive displacement pump and trap the sample exiting the 580B after it has passed through the detector.

6-2 BAG SAMPLE COLLECTION.

One of the most convenient ways to sample the environmental air is to simply trap the entire air sample in a collection bag. As discussed before, the bags used for the calibration of the Model 580B, as discussed under the Calibration Section, can certaiinly be used for collection of the air samples. There are several precautions that must be mentioned immediately relative to the use of bag sample collection. When a bag has been filled with air that has organic vapor in the air sample, the organic vapor molecules will adsorb onto the inside surface of the bag. This adsorption will begin immediately on introduction of the air into the bag. It will continue to progress with time until the vapor molecules adsorb onto the wall of the bag are in equilibrim with the vapor molecules in the air. This equilibrium depends very strongly on the bag material and the chemical entity of the vapor itself. The ambient temperature also has some effect.

As mentioned under the Calibration Procedure, when one is preparing a known vapor concentration in a bag, the bag should be analyzed very rapidly after its preparation to ensure proper calibration of the instrument. The technique here is to use the standard prepared in this fashion as soon as possible such that the adsorption that has occurred is an absolute minimum amount. This adsorption becomes a bit more serious problem in using bags for sample collection. The first problem is simply when one is reusing the bag, one has to be sure that the sample contained in the bag previously has been completely desorbed from the wall. This, in general, can be checked by using clean air to fill a bag allowing the bag to set for a short period of time, about 1 hour, and then analyzing the air in the bag. If on using the 580 to analyze this air, it shows measureable organics then the air in the bag should be dumped and new air introduced and allowed to set for the same period of time. There wil be a reduction of organic vapor on the second go- around. If it is still too high, this procedure is repeated until the bag show: virtually no organic vapor. The bag can be evacuated and reused.

The other problem associated with adsorption and sample collection is that the sample that is collected in the bag musi be analyzed as soon as possible after collection if one is going to determine quantitatively the amount of organic vapor in that bag sample. The longer the sample stays in contact with the bag, the greater will be the adsorption of the organic vapors on the surface of the bag and, therefore, the lower the concentration of the organic vapors in the air sample.

If one is interested here in only doing a qualitative analysis of the organic vapors, that is identify what vapors are present in the air sample, the bag certainly is a convenient way of taking the sample. If one in addition to getting the qualitative analysis desires to quantitate one or more of the specific organic vapors in the sample, the bag sample should be analyzed within an hour of taking this sample. If the bag sample cannot be analyzed this soon, it is recommended that one use the charcoal tube technique explained in the next section.

There are two considerations to be given relative to the size of the bag and, therefore, the size of the sample taken. The first consideration is the amount of sample needed by the laboratory for its analysis. If the analysis is to be done by gas chromatography directly on the air sample, in general only 1 to 5 mL of sample would be required for the analysis. Therefore, this does not become a major consideration here. If, however, other analytical techniques were to be used that would require significantly higher volumes of sample, this should be taken into account.

The other consideration is the sampling time. The Model 580B samples at the rate at which the bag attached to the exit port of the 580B will be filled. If the bag can conveniently hold 10 liters of air, this means that the sampling time can be up to 20 minutes. In general, collection techniques using the Model 580B are not intended to supply a four or eight hour integrated sample. They are used simply to help identify the materials contributing to a high concentration and possibly the analysis of individual toxic organic vapors in that particular air sample. Thus, a 20 minute limitation on sampling time should not be too severe. Certainly larger bags could be used on the exit of the 580B, allowing up to several hours of sampling time should this be desired. The difficulty then becomes that the bags are quite large and physically become difficult to manipulate. It was recommended back in the Calibration Section that perhaps a 10 liter bag would certainly be the convenient bag for the calibration of the 580B. It would appear to be also a convenient bag for collection of the samples. For this purpose, a bag that has no adsorbed vapors on the interior surface is evacuated and closed to the atmosphere. Several of these bags could be carried in a very small container. When the Model 580B is reading high values, and it is impossible to determine the source of the high values, then a bag can be connected to the exit port of the 580B and immediately opened to accept the sample exiting the 580B. The bag is kept connected to this exit as long as the 580B is giving high readings or until the bag has reached its volume capacity. At this point, the bag is removed from the exit port of the 580B, immediately closed, and returned to the laboratory for analysis.

6-3 COLLECTION USING CHARCOAL TUBES

A technique very common in industrial hygiene-type analysis is to use a small charcoal tube as a collection device. An air sample is pulled through the charcoal tube at a known flow rate for a known period of time. This flow rate and time determine the total volume of air or total sample size. The organic vapors in the air are adsorbed on the charcoal in the tube. These vapors are then desorbed from the charcoal by adding a known volume of desorbing solvent, usually carbon disulfide. The organics end up in the carbon disulfide. The carbon disulfide is then injected into a gas chromatograph using Flame Ionization Detection. The individual organic vapors can then be identified and quantitated.

The usual charcoal tubes that are used for this type of work contain two sections. One section has approximately 10 milligrams of charcoal and a backup section has 50 milligrams. The backup section is analyzed separately from the main section to determine if there is organic vapor breakthrough in the main section. These particular size tubes have a recommended maximum flow in the neighborhood of 250 to 300 mL/min. The exit of the Model 580 is at 500 mL/min. The most advantageous way of using a smaller charcoal tube would be to split the exit stream and pass it through two parallel charcoal tubes. This would give approximately 250 mL through each tube. For analysis purposes, the charcoal of each tube is removed and combined using double the amount of solvent that would be required for a single tube.

The amount of total air that can be passed through charcoal tubes certainly depends on the concentration of organic vapor in the air. It also depends to some extent on the particular organic vapor. In general, a total sample through the smaller charcoal tube of 10 liters is a reasonably safe number to use. Since the flow is split exiting the 580B using the smaller charcoal tubes, only 250 mL/min is going through the tube. It would take 40 minutes to accumulate 10 liters passing through each of the tubes. There are charcoal tubes available in the marketplace containing 300 milligrams of charcoal in the front section and 150 milligrams of charcoal in the rear section. These tubes have correspondingly larger diameter and can accommodate higher volumetric throughputs. One of these tubes could be hooked to the exit of the 580B without doing the split. Conceivably since it contains 3 times the amount of charcoal, a safe oeprating total volumetric throughput would be approximately 30 liters. This would be a full hour's operating time on the Model 580B. Again, it must be stressed that the 580B when used in the particular form, is not being used as a personnel sampler to end up with the time weighted average concentration over an eight hour period. The intent here is to identify the high level organics observed on the 580B and to quantitate them following identification to determine the safe working area.

SECTION VII

Communication

The 580B provides a serial (as opposed to parallel) communication port. There is also a communication cable provided for easy link up to a serial printer or RS-232 port of a computer. Logged data may be "dumped" (sent through the communication port) to a serial printer. Many of the 580B parameters may be set by a remote computer by useing the serial port and the 580B communication software (the software is an option part number 580A-9014).

7.1 PRINTER

The 580B can be instructed to send all of it's logged data through the serial port to a printer (or a dumb terminal). The 580B printer mode should be selected (see section 2.7.4).The serial communication cable should then be plugged into the RS-232 port at the rear of the instrument and the other end of the cable plugged into the serial port of a printer. The 580B should finally be instructed to output to the printer (see section 2.7.1).

7.2 COMPUTER

The 580B provides capabilities for remote operation. Appendix A includes a detailed technical explanation of the 580B printer and computer interface protocol. The information in this appendix is sufficient for custom software to be developed for interfacing to the 580B. Thermo Environmental however has developed communication software which implements all of the available communication capabilities in a simple "menu driven" format. Remote communication may also be accomplished by using generic communication software such as CrossTalk. Appendix A will be helpful if this route is taken.

NOTE : Generally the RS-232 port on an IBM PC (or compatible) is a male connector. Since the communication cable provided with the 580B is also male, a "gender changer" (a DB-25 connector which converts from male to female) is needed.

7.3 COMMUNICATION SOFTWARE (OPTIONAL)

There is communication software available which will run on an IBM PC or compatible. The software provides the capability of obtaining or changing the 580B parameters (alarm setting, response factor, or operating mode to name a few). Logged data may be stored to disk or printed to a parallel printer. Concentrations may be read and displayed on the comuter screen. There are a few operations which may not be accomplished remotely (for obvious reasons). The lamp may not be changed remotely. The lamp and pump may not be turned on from the computer either.

NOTE : The communication software will not work unless the 580B is attached via the communication cable.

7.3.1 HOW TO GUIDE FOR COMMUNICATION SOFTWARE

#1. The 580B must be turned on and connected to the computers RS-232 port. The 580B must be in the computer mode (this is the default setting).

#2. The floppy disk should be inserted into the computer. Type 580A (this software was originally developed for the 580A) and then hit return. The introduction screen will appear.

#3. The software defaults to 2400 baud (as does the 580B). If some other baud rate is desired it must match the setting on the 580B.

#4. After selection of the baud rate press return. The main menu will appear.

NOTE : If the computers screen goes blank and the main menu does not appear then there is a problem with the communication link. Check to be sure that the communication cable is plugged into the RS-232 port and that the 580B is on.

APPENDIX C

INSTRUCTION MANUAL FOR FOXBORO MODEL OVA 108
CENTURY ORGANIC VAPOR ANALYZER
(FLAME-IONIZATION DETECTOR)

Instruction

MI

611–133
April 1987

Model OVA 108
CENTURY Organic Vapor Analyzer

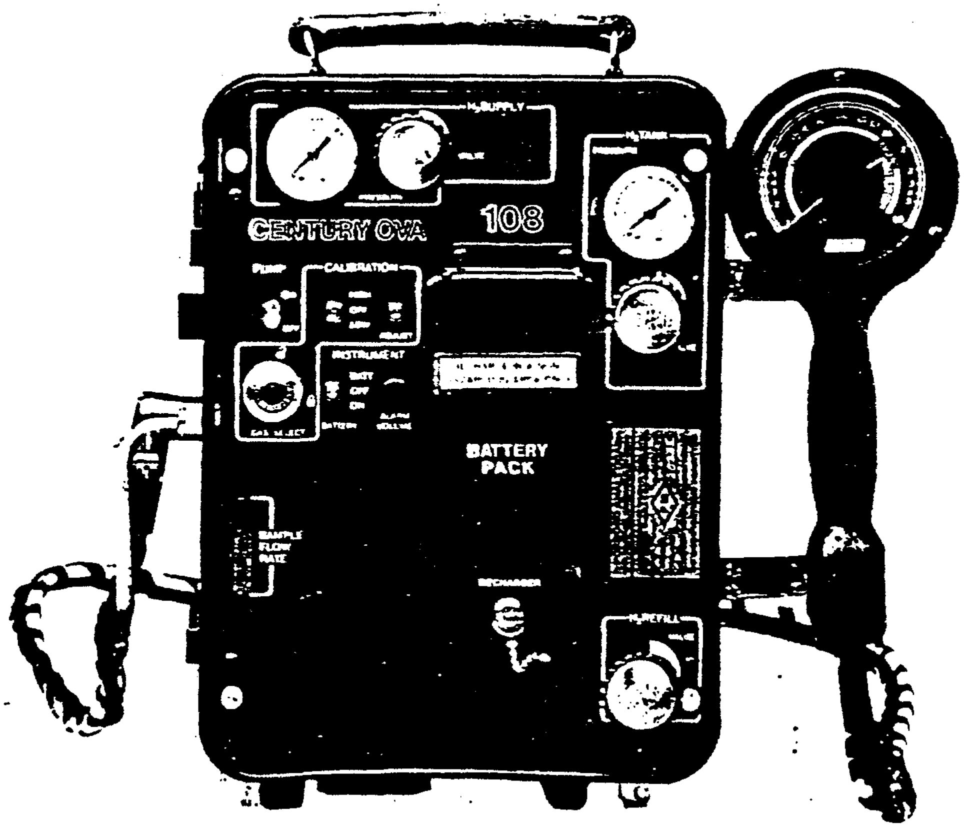


FIGURE 1
PORTABLE ORGANIC VAPOR ANALYZER

INTRODUCTION

The Model OVA 108 CENTURY Organic Vapor Analyzer (OVA 108) is manufactured in two configurations. These are:

- Basic Flame Ionization Detector for monitoring total hydrocarbons
- Gas chromatograph supplied with two columns

A battery charger can be ordered for either 120 V ac, 60 Hz or for 220 V ac, 50 Hz.

Classifications are:

- FM certified for use in Class I, Groups A, B, C, and D, Division 1 hazardous environments.
- BASEEFA certified intrinsically safe, Ex ib, for IIC, Zone 1, Temperature Class T6. BASEEFA No. 7[illegible]04[illegible] std. SFA 3007.

Accessories for the OVA 108 are:

- Strip Chart Recorder - either FM or BASEEFA certified.
- Activated Charcoal Filter Assembly, used for zeroing the analyzer in a contaminated environment. Also used with dessicant as a moisture trap.
- Sample Dilutor Assembly for 10:1, 25:1, or 50:1 sample dilution.
- Septum Adapter for direct, online injection with the GC.
- Portable Isothermal Pack (PIP) for temperature control of GC columns.

The OVA 108 is highly a sensitive instrument designed to measure trace quantities of organic materials in air. It is essentially a flame ionization detector such as utilized in laboratory gas chromatographs and has similar analytical capabilites. The flame ionization detector is an almost universal detector for organic compounds with the sensitivity to measure in the parts per million range (V/V) in the presence of atmospheric moisture, nitrogen oxides, carbon monoxide, and carbon dioxide.

The instrument has broad application since it has a chemically resistant air sampling system and can be readily calibrated to measure almost all organic vapors. Designed for use as a portable survey instrument, it can also be readily adapted to fixed remote monitoring or mobile installations. It is ideal for the determination of many organic air pollutants and for monitoring the air in potentially contaminated areas.

The OVA 108 is certified by Factory Mutual Research Corporation (FM) for use in Class I, Groups A, B, C, & D, Division I hazardous locations. Similar foreign certifications have been obtained, including BASEEFA. This requirement is especially significant in industries where volatile flammable petroleum or chemical products are manufactured or used and for instruments which are used in portable surveying or for analyzing concentrations of gases and vapors. Such instruments must be incapable, under normal or abnormal conditions, of causing ignition of hazardous mixtures in the air. In order to maintain the certified safety, it is important that the precautions outlined in this manual be practiced and that no modifications be made to these instruments.

It is highly recommended that the entire manual be read before operating the instrument. It is essential that all portions relating to safety of operation and maintenance be thoroughly understood.

Reference Literature

MI 611-102 Operation of Dilutor Kit
MI 611-105 Operation of Portable Isothermal Pack

GENERAL DESCRIPTION

The OVA 108 Analyzer is designed to detect and measure hazardous organic vapors and gases found in most industries. It has broad application since it has a chemically resistant sampling system and can be calibrated to almost all organic vapors. It can provide accurate indication of gas concentration from 1 to 10,000 ppm or 1 percent. While designed as a lightweight portable instrument, it can be permanently installed to monitor a fixed point.

The instrument utilizes the priciple of hydrogen flame ionization for detection and measurement of organic vapors. The instrument measures organic vapor concentration by producing a response to an unknown sample, which can be related to a gas of known composition to which the instrument has previously been calibrated. During normal survey mode operation, a continuous sample is drawn into the probe and transmitted to the detector chamber by an internal pumping system.

The sample stream is metered and passed through particle filters before reaching the detector chamber. Inside the detector chamber, the sample is exposed to a hydrogen flame which ionizes the organic vapors. When most organic vapors burn, they leave positively charged carbon-containing ions. An electric field drives the ions to a collecting electrode. As the positive ions are collected, a current corresponding to the collection rate is generated. This current is measured with a linear electrometer preamplifier which has an output signal proportional to the ionization current. A signal conditioning amplifier is used to amplify the signal from the preamp and to condition it for subsequent meter or external recorder display. The display is an integral part of the Probe/Readout Assembly and has 270° scale deflection.

In general, the hydrogen flame ionization detector is more sensitive for hydrocarbons than any other class of organic compounds. The response of the OVA varies from compound to compound, but gives repeatable results with all types of hydrocarbons; i.e., saturated hydrocarbons (alkanes), unsaturated hydrocarbons (alkenes and alkynes) and aromatic hydrocarbons.

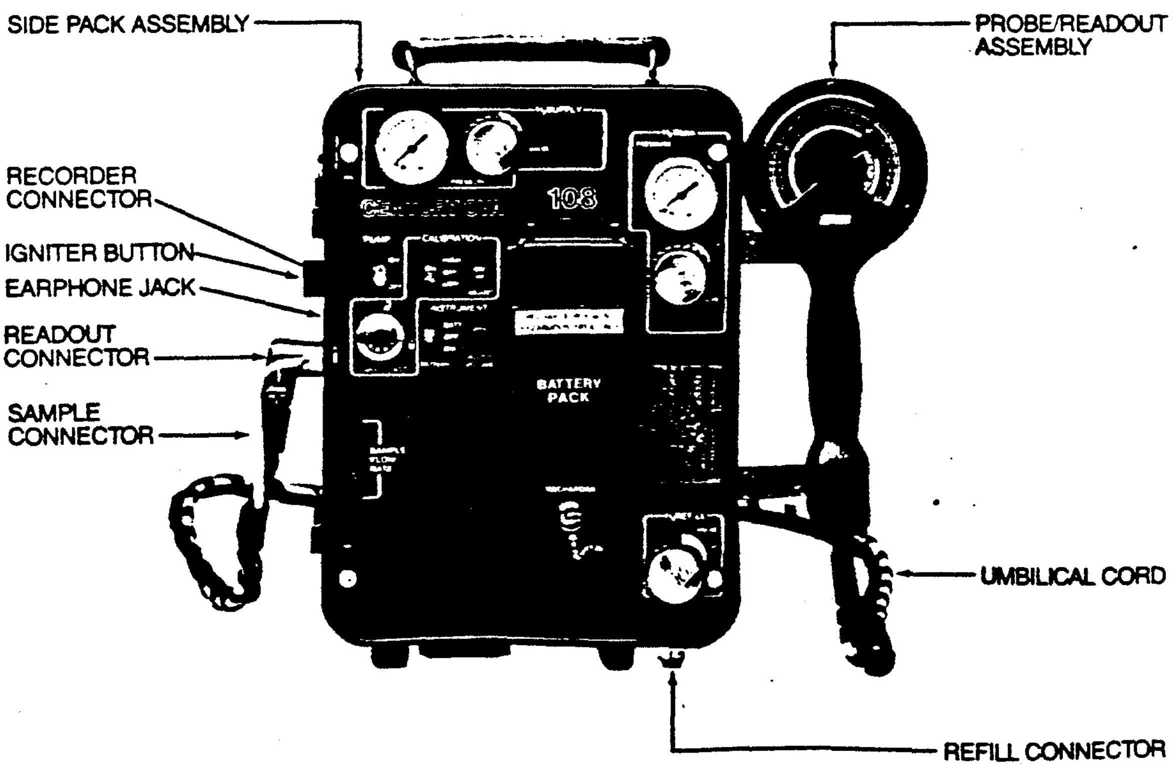


Figure 2
PORTABLE ORGANIC VAPOR ANALYZER
Model OVA 108

Typical response of various hydrocarons, relative to methane is as follows:*

Compound	Relative Response (percent)
Methane	100 (reference)
Hexane	70
Propane	64
N-butane	61
N-petane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Ethane	90

Compounds containing oxygen, such as alcohols, ethers, aldehydes, carbolic acid and esters give a lower response than that observed for hydrocarbons. This is particularly noticeable with compounds having a high ratio of oxygen to carbon such as the lower members of each series which have one, two or three carbons. With compounds containing higher numbers of carbons, the effect is diminished to such an extent that the response is similar to that of the corresponding hydrocarbons.

Nitrogen-containing compounds (i.e., amines, amides, and nitriles) respond in a manner similar to that observed for oxygenated materials. Halogenated compounds also show a lower relative response as compared with hydrocarbons. Materials containing no hydrogen, such as carbon tetrachloride, give the lowest response; the presence of hydrogen in the compounds results in higher relative responses. Thus, $CHCl_3$ gives a much higher response than does CCl_4. As in the other cases, when the carbon to halogen ratio is 5:1 or greater, the response will be similar to that observed for simple hydrocarbons.

Extensive research has been done by U.S. EPA on response factors. The following reports are available through National Technical information service:

1) Response factors of VOC Analyzers Calibrated with Methane for Selected Organic Chemicals PB 81-136194

2) Response Factors of VOC Analyzers at a Meter reading of 10,000 ppm for Selected Organic Compounds PB 81-234817

*NOTE: Each OVA detector will have slightly different responses for organic vapors relative to methane. The user should determine responses for his individual instrument. The typical response of various compounds relative to methane is as follows:

KETONE	
Acetone	60
Methyle ethyl ketone	80
Methyl isobutyl ketone	100

The OVA has negligible response to carbon monoxide and carbon dioxide which, due to their structure, do not produce appreciable ions in the hydrogen flame. Thus, other organic materials may be analyzed in the presence of CO and CO_2.

Applications

1) Measurement of most toxic organic vapors present in industry for compliance with Occupational Safety and Health Administration (OSHA) requirements.

2) Process Leak Detection in the Petroleum, Chemical, or Natural Gas Industries.

3) Equipment Leaks of Volatile Organic Carbon (VOC), Reference Methods 18 and 22, Fugitive Emissions, EPA 40, Code of Federal Regulation (CFR), Part 60.

4) Landfill Monitoring.

5) Source identification and measurement for fugitive emissions (leaks) as defined by EPA.

6) Benzene Equipment Leaks, Fugitive Emissions Sources, EPA 40, CFR Part 61.

7) Equipment Leaks of VOC from Onshore Natural Gas Processing Plants, EPA 40, CFR Part 61.

8) Stack Monitoring for VOC.

9) Quality Control Monitoring Carbon Absorption Systems.

10) Quality Control Monitoring Carbon to leak checking, pressurized system checks, combustion efficiency checks, etc.

ALCOHOLS	
Methyl alcohol	15
Ethyl	25
Isopropyl	65

HALOGEN COMPOUNDS	
Carbon tetrachloride	10
Chloroform	65
Trichloroethylene	70
Vinyl chloride	35

Major Features

The basic instrument consists of two major assemblies, the Probe/Readout Assembly and the Side Pack Assembly (See Figure 2). The recorder is optional on all models, but is normally used with all instruments which incorporate the GC Option. The output meter and alarm level adjustments are incorporated in the Probe/Readout Assembly.

The Side Pack Assembly contains the remaining operating controls and indicators, electronic circuitry, detector chamber, hydrogen fuel supply, and electrical power supply.

Other major features are: logarthmic scale readout, approximately two second response time and portable operating time of 8 hours for fuel supply and battery pack. A battery test feature allows charge condition to be read on the meter. Hydrogen flame-out is signified by an audible alarm plus a visual indication on the meter. The instrument contains a frequency modulated detection alarm which can be preset to sound at a desired concentration level. The frequency of the detection alarm varies as a function of detected level giving an audible indication of organic vapor concentration. An earphone is provided to allow the operator to hear the alarm in noisy areas or to avoid workers.

During use, the Side Pack Assembly can be carried by the operator on either his left or right side or as a back pack. The Probe/Readout Assembly can be detached from the Side Pack Assembly and disassembled for transport and storage.

Standard Accessories

A variety of sampling probes can be used. In addition, small diameter tubing can be used for remote sampling or electrically insulated flexible extensions can be used for places that are difficult to reach.

Telescoping Probe

Probe length can be increased or decreased over a 22 to 30 inch range to suit the individual user. A knurled locking nut is used to lock the probe at the desired length. The probe is attached to the Readout Assembly. When appropriate, the probe is replaced with a Close Area Sampler, which is supplied as a standard accessory.

Sampling Accessories

Part Number	Description
510125-1	Close area sampler - Connects directly to the readout assembly.
CR009LX	Telescoping probe - Adjustable length - accommodates the probe listed below.
510126-1	Tubular area sampler Used with the telescoping probe.

Particulate Filters

The primary filter of porous or sintered stainless steel is located behind the sample inlet connector (see Side Pack Assembly drawing). In addition, a replaceable porous metal filter is installed in the "close area" sampler.

Carrying Case

An instrument carrying case is provided to transport, ship and store the disassembled Probe/Readout Assembly, the Side Pack Assembly and other equipment.

Specifications

READOUT: 1-10,000 ppm logarth.
SAMPLE FLOW RATE: 1 1/2 to 2 1/2 litre per minute at 22°C, 760 mm, using close area sampler.
RESPONSE TIME: Approximately 2 seconds for 90% of final reading.
PRIMARY ELECTRICAL POWER: 12 volt (nominal) battery pack.
FUEL SUPPLY: Approximately 75 mL volume tank of pure hydrogen, maximum pressure 2400 psig, fillable in case.
HYDROGEN FLOW RATE: Factory set 12.5 0.5 mL/min (minus GC option) 11.0 0.5 mL/min (GC models).
PORTABLE OPERATING TIME: Minimum 8 hours with battery fully charged, hydrogen pressure at 1800 psig.
PHYSICAL DIMENSIONS: 9" x 12" x 5" (229 mm x 305 mm x 127 mm) Side-pack only.
WEIGHT: 12 pounds (5.5 kg) (sidepack and hand-held probe assembly).
DETECTION ALARM: Audible alarm plus meter indication. User preset to desired level.
FLAME-OUT ALARM: Audible alarm plus meter indication (needle drops off scale in negative direction).

BATTERY TEST: Battery charge condition indicated on readout meter. Upon activation of momentary contact switch, a meter reading above the indicator line means that there is 4 hours minimum service life remaining (at 22°C).
FILTERS: In-line sintered metal filters will remove particles larger than 10 microns.
OPERATING TEMPERATURE RANGE: 10°C to 40°C.
MINIMUM AMBIENT TEMPERATURE: 15°C for Flame Ignition (coldstart).
ACCURACY: Based on the use of a calibration gas for each range:

Calibration Temp. °C	Operating Temp. °C	Accuracy in Individual Full Scale
20 to 25	20 to 25	± 20%, 1-10,000 ppm
20 to 25	10 to 40	± 20%, 1-10,000 ppm

RELATIVE HUMIDITY: 5% to 95%, Effect on accuracy: 20% of individual full scale.
RECORDER OUTPUT: 0 to 5 volts.
MINIMUM DETECTABLE LIMIT (METHANE): 0.2 ppm
STANDARD ACCESSORIES:
1. Instrument carrying and storage case
2. Hydrogen fuel filling hose assembly
3. Battery charger
4. Earphone
5. Various sampling fixtures - close area sampler, tubular sampler
6. Maintenance tool kit
7. Operators manual (2 each)
8. Padded leather carrying straps

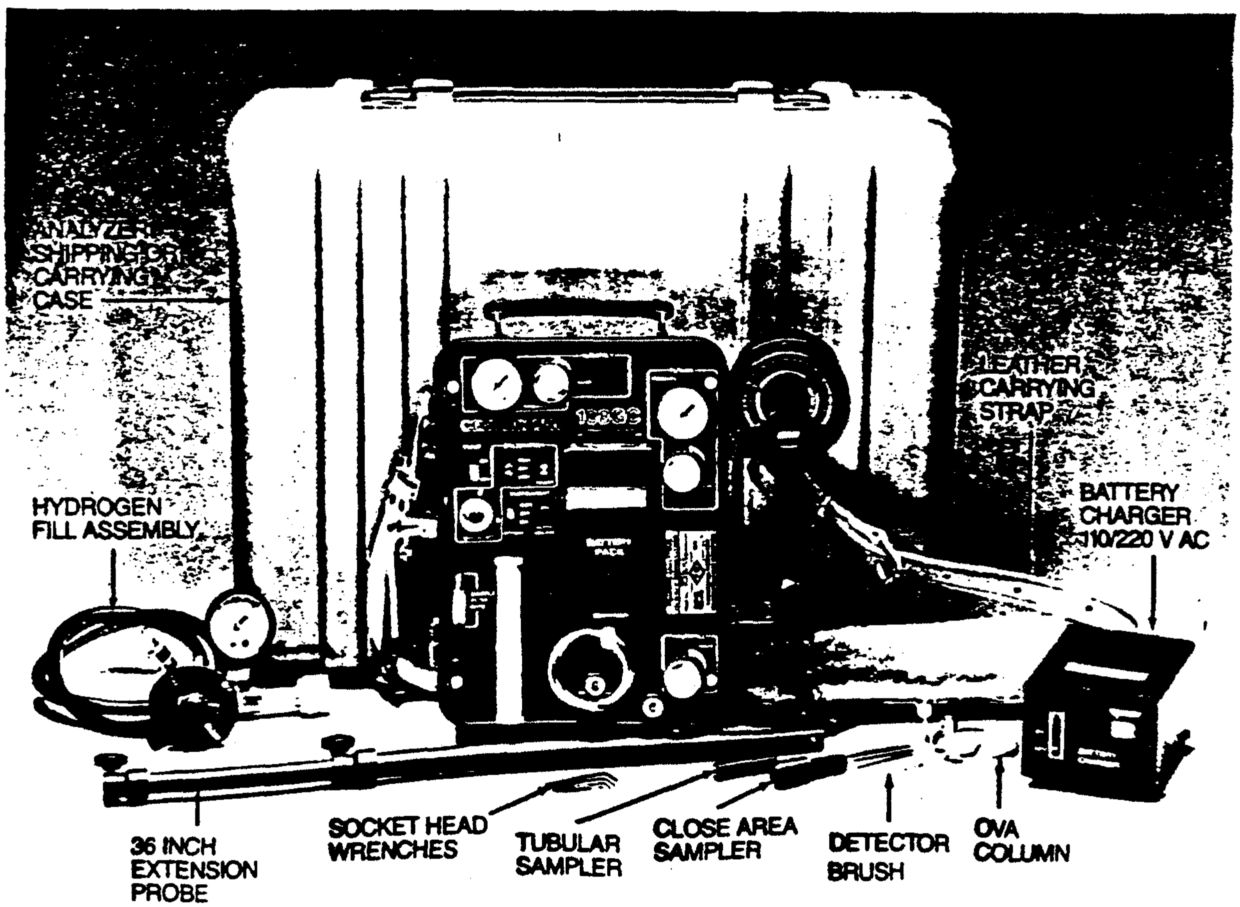


FIGURE 3
OVA-128 ANALYZER COMPONENTS
(Gas Chromatograph Model Shown)

OPERATING PROCEDURES

Sidepack Assembly

Controls and Indicators

1) INSTR/BATT Test Switch* - Three position toggle switch controls all instrument electrical power except the pump and alarm power. It also permits display of the battery charge condition on the readout meter.

2) PUMP (ON/OFF) Switch* - Toggle switch controls power to the internal pump and audio alarms.

3) Igniter Switch - Momentary push button switch connects power to the igniter coil in the detector chamber and simultaneously disconnects power to pump.

4) CALIBRATE Switch - Three position toggle switch introduces the HIGH or LOW calibration signal currents. The OFF position is used during sample measurement.

5) CALIBRATE Screwdriver Adjustment - Adjusts the meter reading during calibration procedures.

6) GAS SELECT KNOB (span control) - Ten turn dial readout potentiometer sets the gain of the instrument (commonly referred to as span control).

7) Recorder Connector - Five-pin connector used to connect the instrument to an external recorder with the following pin connections:

   Pin E - + 12 V dc
   Pin H - Ground
   Pin B - Signal 0 to 5 V dc

8) Charger Connector - BNC connector used to connect the battery pack to the battery charger.

9) HYDROGEN TANK VALVE - Valve used to supply or close off the fuel supply from the hydrogen tank.

10) HYDROGEN TANK PRESSURE Indicator - High pressure gauge measures pressure in the hydrogen fuel tank which is an indication of fuel supply.

11) HYDROGEN SUPPLY VALVE - Valve used to supply or close off hydrogen fuel to the detector chamber.

12) HYDROGEN SUPPLY PRESSURE Indicator - Low pressure gauge used to monitor hydrogen pressure at the capillary restrictor.

13) SAMPLE FLOW RATE Indicator - Indicator to monitor the sample flow rate.

14) REFILL CONNECTION - ¼ in AN fitting to connect the hydrogen refill hose to the instrument.

15) REFILL VALVE - Valve to open one end of the instrument fuel tank for refilling with hydrogen.

16) EARPHONE JACK - Used to connect the earphone; speaker is disabled when earphone is used.

17) VOLUME Knob - Potentiometer adjusts the volume of the internal speaker and earphone.

18) Readout and Sample Connectors - Used to connect the sample hose and umbilical cord from the Probe/Readout to the Side Pack.

Probe/Readout Assembly

Controls and Indicators

1) Meter - Logarithmically scaled 270° meter displays the output signal level in ppm or percent.

2) Alarm Level Adjust Knob - Potentiometer (located on the back of the Readout Assembly) is used to set the concentration level at which the audible alarm is actuated. The procedure to set the alarm level is explained under Startup Procedure.

Startup Procedure

a) Connect the Probe/Readout Assembly to the Sidepack Assembly by attaching the sample line and electronic jack to the Sidepack.

b) Select the desired sample probe (close area sampler or telescoping probe) and check that a particulate filter is installed. Before tightening the knurled nut, check that the probe accessory is firmly seated against the flat seals in the probe handle and the tip of the telescoping probe.

c) Move the Instr/Batt Switch to the test position. The meter needle should move to a point beyond the white line, indicating that the integral battery has more than 4 hours of operating life before recharging is necessary.

*Special Switch - switch handle must be pulled to change position. This prevents accidental movement.

d) Move the Instr/Batt Switch to the "ON" position and allow a 5 minute warm-up.

e) To set the audible alarm to a predetermined level, first turn the PUMP Switch to ON, then adjust the meter pointer to the desired level, using the CALIBRATE screwdriver adjustment. Turn the Alarm Level Adjust Knob on the back of the Readout Assembly until the audible alarm just comes on. The instrument is now set to activate the alarm when the level exceeds that of the setting. Adjust speaker volume with the VOLUME Knob. If the earphone is used, plug in and readjust volume. Move the CALIBRATE Switch to HIGH and check that the meter reads full scale. If not, adjust meter reading to full scale with the CALIBRATE screwdriver adjustment.

f) Set the CALIBRATE Switch to LOW and verify that the meter reads 10 ppm. Set the CALIBRATE Switch to HIGH and verify that the meter reads 10,000 ppm. Set the CALIBRATE Switch to OFF.

g) Set the PUMP Switch to ON and observe the SAMPLE FLOW RATE Indicator. Indication should be approximately 2 on the scale. The audible flame-out alarm will now be on until the hydrogen flame is ignited (step i below).

h) Open HYDROGEN TANK VALVE one (1) turn and observe the reading on the HYDROGEN TANK PRESSURE Indicator. Approximately 150 psi of pressure is consumed for each hour of operation. Open HYDROGEN SUPPLY VALVE one (1) turn and observe the reading on the HYDROGEN SUPPLY PRESSURE Indicator.

⚠ CAUTION

Do not leave HYDROGEN SUPPLY VALVE open when the pump is not running, as this will allow hydrogen to accumulate in the detector chamber.

i) Press igniter button. There will be a slight "pop" as the hydrogen ignites and the meter pointer will move upscale and return to a position upscale of 1 ppm. Immediately after ignition, release the igniter button. After ignition, the audible flameout alarm will go off. Do not depress igniter button for more than 6 seconds. If burner does not ignite, let instrument run for several minutes and try again. After ignition, the meter pointer will indicate the background concentration.

j) After chamber ignition, allow approximately five minutes for the chamber to reach operating temperature. After warm up, the meter should display a hydrocarbon concentration between 5 and 10 ppm. If the alarm level is to be set just above the normal background detection level, turn the Alarm Level Adjust Knob (back of Readout Assembly) until it actuates slightly above background.

THE INSTRUMENT IS NOW READY FOR USE.

Operating Procedures

a) Set the CALIBRATE Switch to the OFF position to place the analyzer in the normal operating mode. Survey the areas of interest while observing the meter and/or listening for the audible alarm indication. For ease of operation, carry the Side Pack Assembly positioned on the side opposite the hand which holds the Probe/Readout Assembly. For broad surveys outdoors, the pickup probe should be positioned several feet above ground level. When making quantitative readings or pinpointing, the pickup probe should be positioned at the point of interest.

b) When organic vapors are detected, the meter pointer will move upscale and the audible alarm will sound when the setpoint is exceeded. The frequency of the alarm will increase as the detection level increases.

If the flame-out alarm is actuated, check that the pump is running, then press the igniter button. Under normal conditions, flame-out results from sampling a gas mixture that is above the lower explosive level which causes the hydrogen flame to extinguish. If this is the case, reignition is all that is required to resume monitoring. Another possible cause for flame-out is restriction of the sample flow line which would not allow sufficient air into the chamber to support combustion. The normal cause for such restriction is a clogged particle filter.

It should be noted that the chamber exhaust port is on the bottom of the case and blocking this port with the hand will cause fluctuations and/or flame-out.

Shut Down Procedures

The following procedure should be followed for shut down of the equipment:

A. Close HYDROGEN TANK VALVE
B. Close HYDROGEN SUPPLY VALVE
C. Move INSTR Switch to OFF
D. Wait 5 seconds and move PUMP Switch to OFF. INSTRUMENT IS NOW IN A SHUT DOWN CONFIGURATION.

Fuel Refilling

NOTE: Use PREPURIFIED or ZERO grade hydrogen (certified total hydrocarbons as methane 0.5 ppm recommended).

a) The instrument and the charger should be completely shut down during hydrogen tank refilling operations. Refilling should be done in a ventilated area. THERE SHOULD BE NO POTENTIAL IGNITERS OR FLAME IN THE AREA.

WARNING

A safe refill operation means there are no hydrogen leaks. Before any valves are opened, firmly tighten connections to the hydrogen supply tank and the instrument refill fitting. During the filling operation, if escaping hydrogen is heard (except during BLEED) close valves off and correct the leaks before proceeding.

b) If you are making the first filling on the instrument or if the filling hose has been allowed to fill with air, the filling hose should be purged with hydrogen prior to filling the instrument tank. This purging is not required for subsequent fillings.

c) The filling hose assembly should be left attached to the hydrogen supply tank when possible. Ensure that the FILL/BLEED Valve on the instrument end of the hose is in the OFF position. Connect the hose to the refill connection on the Side Pack Assembly.

d) Open the hydrogen supply bottle valve slightly. Open the REFILL VALVE and the HYDROGEN TANK VALVE on the instrument panel and place the FILL/BLEED Valve on the filling hose assembly in the FILL position. The pressure in the instrument tank will be indicated on the OVA HYDROGEN TANK PRESSURE Indicator.

The hydrogen filling assembly contains a flow limiting safety device. Approximately 2 minutes are required to fill the instruments hydrogen tank.

e) After the instrument fuel tank is filled, close the REFILL VALVE on the panel, the FILL/BLEED Valve on the filling hose assembly and the hydrogen supply bottle valve.

f) The hydrogen trapped in the hose should now be bled off to atmospheric pressure.

CAUTION

In the step which follows, hydrogen gas will be released to the atmosphere. Hydrogen/air mixtures are flammable and easily ignited. Do not perform the procedure in the presence of a source of ignition.

g) The hose is bled by turning the FILL/BLEED Valve on the filling hose assembly to the BLEED position. After the hose is bled down to atmospheric pressure, the FILL/BLEED Valve should be turned to the FILL position to allow hydrogen trapped in the connection fittings to go into the hose assembly. Again turn the FILL/BLEED Valve to the BLEED position to exhaust the trapped hydrogen. Then turn the FILL/BLEED Valve to OFF to keep the hydrogen at one atmospheric in the hose so that at the time of the next filling there will be no air trapped in the filling line.

h) Close the HYDROGEN TANK VALVE.

i) With the HYDROGEN TANK VALVE and the HYDROGEN SUPPLY VALVE closed, a small amount of HYDROGEN at high pressure will be present in the regulators and plumbing. As a leak check, observe the HYDROGEN TANK PRESSURE Indicator while the remainder of the system is shut down and ensure that the pressure reading does not decrease rapidly (more than 350 psi/h) which would indicate a significant leak in the supply system.

Battery Charging

⚠ WARNING

Never charge in a hazardous environment.

a) Plug charger connector into mating connector on battery cover and insert ac plug into 115 V ac wall outlet.

b) Move the battery charger switch to the ON position. The lamp above the switch button should illuminate.

c) Battery charge condition is indicated by the meter on the front panel of the charger; meter will deflect to the left when charging. When fully charged, the pointer will be in line with "charged" marker above the scale.

d) Approximately one hour of charging time is required for each hour of operation. However, an overnight charge is recommended. The charger can be left on indefinitely without damaging the batteries. When finished, move the battery charger switch of OFF and disconnect from the Side Pack Assembly.

THE FOLLOWING ARE SPECIAL INSTRUCTIONS FOR RECHARGING BATTERIES WHICH HAVE BEEN COMPLETELY DISCHARGED.

It has been established that the above battery charging procedures may not be effective when the operator has allowed the battery to COMPLETELY discharge.

When this happens and the above procedures fail to charge the battery, perform the following additional steps:

e) Remove the battery from the instrument case.

f) Connect to any variable dc power supply.

g) Apply 40 volts at ¼ ampere maximum.

h) Observe the power supply meter. As soon as the battery begins to draw current, gradually reduce the power maintaining ¼ A maximum until the meter reads approximately 15 volts.

NOTE: The time required to reach the 15 volt reading will depend on degree of discharge.

i) Repeat steps (a), (b), (c), and (d) above to complete the charging cycle.

SUMMARY OF OPERATING PROCEDURES

Start Up

a) Check battery condition by moving the INSTR Switch to the BATT position.

b) Move INSTR Switch to ON and allow five (5) minutes to warm-up.

c) Use the CALIBRATE Switch to check electronic calibration as follows:

- In LOW position, the readout should display 10 ppm.
- In HIGH position, the readout should display 10,000 ppm or 1%.

d) Return the CALIBRATE switch to the OFF position.

e) Move PUMP Switch to ON position, then place instrument in vertical position and check SAMPLE FLOW RATE indication. The normal range is 1.5 to 2.5 units. If less, check filters.

f) Open the HYDROGEN TANK VALVE and the HYDROGEN SUPPLY VALVE. Wait one minute for hydrogen to purge the system.

g) Depress Igniter Button until burner lights. Do not depress Igniter Button for more than six seconds. (If burner does not ignite, let hydrogen flow for one minute and again attempt ignition).

h) After ignition, allow approximately five minutes for instrument warm-up. After warm-up, the meter should display a normal background hydrocarbon concentration between 5 and 10 ppm.

Shut Down

a) Close the HYDROGEN SUPPLY VALVE

b) Close the HYDROGEN TANK VALVE

c) Move the INSTR Switch and PUMP Switch to OFF

d) Instrument is now in shut down configuration

CALIBRATION

The OVA-108 is capable of responding to nearly all organic compounds. For precise analyses, it is necessary to calibrate the instrument with the specific compound of interest. This is especially true for materials containing elements other than carbon and hydrogen.

The analyzer utilizes a two point internal electronic calibration system, wherein reference signals are generated by introducing small currents at the input to the electrometer preamplifier. These reference signals are introduced by a CALIBRATE Switch on the instrument panel. The reference points in the OVA-108 are 10 ppm and 10,000 ppm (1%).

The Model OVA-108 was designed for use in applications requiring the instrument response to be readily and rapidly calibrated to a variety of organic compounds.

To accomplish this, the OVA-108 incorporates a GAS SELECT control on the instrument panel which is used to set the internal calibration reference signals to a predetermined point corresponding to a particular organic vapor compound.

In addition, three electronic adjustments are provided on the electronics board to calibrate and align the electronic circuits. One adjustment potentiometer, R-38, is used to set the power supply voltage and is a one-time factory adjustment. R-4 is used for setting the amplifier gain and R-16 is used for setting the amplifier bias. Access to these adjustments is accomplished by removing the instrument from its case. Figure 4 indicates the location of the adjustments.

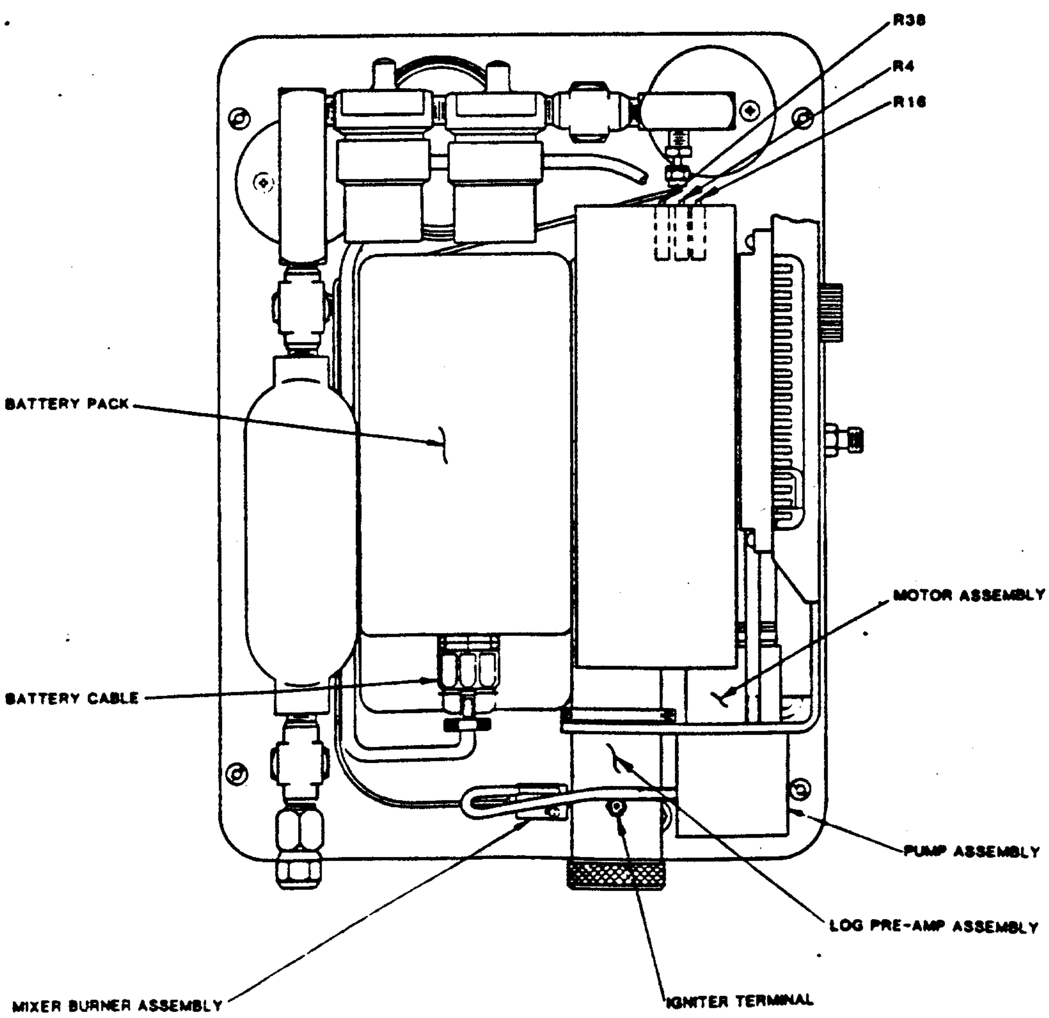


FIGURE 4
LOCATION OF INTERNAL ELECTRONIC ADJUSTMENT

Primary Calibration for Methane

a. Prepare two known concentrations of methane gas in air, preferably 100 ppm and 10,000 ppm (1%).

b. Place the OVA in normal operation and permit it to warm up for at least 15 minutes.

c. Introduce the 100 ppm sample and rotate the Calibrate Adjustment for 100 ppm on the meter.

d. Introduce the 10,000 ppm mixture and adjust R-4 on the electronics board for 10,000 ppm.

e. Repeat Steps c and d until no further adjustment is necessary.

f. Close the Hydrogen Supply Valve and wait until the flame is extinguished.

g. Place the Calibrate Switch in the Low position and rotate the Gas Select Knob until the meter reads 10 ppm.

h. Place the Calibrate Switch in the High position and adjust R-16 on the electronics board for 10,000 ppm.

i) Repeat Steps g and h until no further adjustment is necessary. The analyzer is now calibrated.

Recalibration to Various Organic Vapors

The OVA 108 is capable of responding to nearly all organic compounds. At the time of manufacture, the analyzer is calibrated to mixtures of methane in air. For precise analysis it is necessary to recalibrate with the specific compound of interest. The GAS SELECT control is used to set the electronic calibration for a particular compound. To facilitate return to the calibration for methane, the setting of the GAS SELECT control should be recorded prior to any adjustments.

• Before adjusting the GAS SELECT control, use the CALIBRATE switch to check electronic calibration as follows:
- In LOW position, the readout should display 10 ppm
- In HIGH position, the readout should be at full scale reading

With the instrument in operation, draw a sample of the calibration gas into the instrument. The CALIBRATE ADJUST control is then used to shift the OVA meter reading to correspond with the actual concentration of the calibration gas mixture. Close the hydrogen supply valve and wait until the flame is extinguished. Set the CALIBRATE switch to the HIGH position and adjust the GAS SELECT control for full-scale reading. The instrument is now calibrated for the vapor mixture used, and the setting of the GAS SELECT control now represents the calibration set-point for that gas.

The above procedure can be performed for any number of compounds. To measure a particular compound or to return to the calibration for methane, the GAS SELECT control is turned to the predetermined setting for that compound. With the flame extinguished and with the CALIBRATE switch in HIGH position the CALIBRATE ADJUST control is then set to full scale reading.

USING EMPIRICAL DATA

Relative response data may be obtained, which can then be used to estimate concentration of various vapors. With the instrument calibrated to methane, obtain the concentration reading for a calibration sample of the test vapor. The relative response, in percent, for that test vapor would then be:

Relative Response (%) =

$$\frac{\text{Measured Response}}{\text{Concentration of Standard}} \times 100$$

Calibration Standards

Commercially available standard samples offer the most convenience and reliability and are recommended for the most precise analyses. Always remember to obtain the cylinder with the desired sample and the "balance as air". Sample should be drawn from the cylinder into a collapsed sample bag, then drawn from the bag by the instrument to prevent a pressure or vacuum at the sample inlet.

GASEOUS AND LIQUID SAMPLES

Obtain a five (5) gallon glass bottle and determine its volume by measuring the volume of water needed to fill it (use of a 1000 ml graduated cylinder, obtainable from scientific supply houses, is convenient). Another approach is to weigh the empty bottle, fill it with water and weigh again. The difference between the two values is the weight of water. By multiplying the weight of water in pounds by 0.455, obtain the volume of the bottle in liters. Empty the water and allow the bottle to dry. Place a one-foot piece of teflon tubing in the flask to aid in mixing the vapors uniformly with the air. The volume of such a bottle should be about 20 liters, which is 20,000 ml. If the volume were 20,000 ml, then a 2 ml sample of a gas placed in the bottle would be equivalent to 200 ml per 2 million ml or 1000 ppm (V/V). Use of a gas tight syringe, readable in 0.01 ml, allows the preparation of mixtures in the 1-2 ppm range, which are sufficient for the quantitative estimation of concentrations. A plastic stopper is loosley fitted to the top of the bottle and the needle of the syringe placed inside the jug neck and the stopper squeezed against the needle to decrease leakage during sample introduction. Inject the sample into the bottle and withdraw the needle without removing the stopper. Put the stopper in tight and shake the bottle for a few minutes with sufficient vigor that the plastic tubing in the bottle moves around to ensure good mixture of the vapors with the air.

Calculations

$$\text{Injection} = \frac{\text{Volume Concentration X Molecular Weight X System Volume}}{\text{Density X Molar Volume at STP*}}$$

$$= \frac{(C)\quad(MW)\quad(V)}{(D)\quad(V)}$$

Using the Ideal Gas Law, PV=RT, the molar volume of any gas at STP (25°C and 1 atm) is:

$$V = \frac{RT}{P} = \frac{\text{Universal Gas Constant x Temperature}}{\text{Pressure}}$$

$$= \frac{\left[\left(0.08206\ \frac{\text{litre atm}}{\text{mol K}}\right)\right](298.15\ \text{K})}{1\ \text{atm}}$$

$$= (24.47\ \text{L})\quad(\text{mol}^{-1})$$

Therefore, the injection volume necessary to prepare 1 liter of a 100 ppm sample of hexane would be:

$$\text{Injection Volume} = \frac{(100\ \text{ppm})\ \left[(86.18\ \text{g})\ \ (\text{mol}^{-1})\right]\ (1\ \text{liter})}{\left[(0.659\ \text{g})\ \ (\text{mL}^{-1})\right]\left[(24.47\ \text{L})\ \ (\text{mol}^{-1})\right]\left[(1000\ \text{mL})\,(1^{-1})\right]}$$

$$= 0.534\ \mu\text{L}$$

* STP - Standard Temperature and Pressure

Theory

In general, a hydrogen flame ionization detector is more sensitive for hydrocarbons than any other class of organic compounds. The response of the OVA varies from compound to compound, but gives excellent repeatable results with all types of hydrocarbons; i.e., saturated hydrocarbons (alkenes and alkynes) and aromatic hydrocarbons.

Typical response of various hydrocarbons to relative methane is as follows:

Compound	Relative Response (percent)
Methane	100 (reference)
Propane	64
N-butane	61
N-pentane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Ethane	90

Compounds containing oxygen, such as alcohols, ethers, aldehydes, carbolic acid and esters give a somewhat lower response than that observed for hydrocarbons. This is particularly noticeable with those compounds having a high ratio of oxygen to carbon such as found in the lower numbers of each series which have only one, two or three carbons. Both compounds containing higher numbers of carbons, the effect of the oxygen is diminished to that of the corresponding hydrocarbons.

Nitrogen-containing compounds (i.e., amines, amides and nitriles) respond in a manner similar to that observed for oxygenated materials. Halogenated compounds also show a lower relative response as compared with hydrocarbons. Materials containing no hydrogen, such as carbon tetrachloride, give the lowest response; the presence of hydrogen in the compounds results in higher relative responses. Thus, $CHCl_3$ gives a much higher response than does CCl_4. As in the other cases, when the carbon to halogen ratio is 5:1 or greater, the response will be similar to that observed for simple hydrocarbons.

The typical relative response of various compounds to methane is as follows:

KETONES	
Acetone	60
Methyl ethyl ketone	80
Methyl isobutyl ketone	100
ALCOHOLS	
Methyl alcohol	15
Ethyl	25
Isopropyl	65
HALOGEN COMPOUNDS	
Carbon tetrachloride	10
Chloroform	65
Trichloroethylene	70
Vinyl chloride	35

The OVA has negligible response to carbon monoxide and carbon dioxide which, due to their structure, do not produce appreciable ions in the detector flame. Thus, other organic materials may be analyzed in the presence of CO and CO_2.

NOTE: Each OVA detector will have slightly different responses for organic vapors relative to methane. The user should determine responses for his individual instrument.

SAFETY PRECAUTIONS

The OVA 108 has been tested and certified by Factory Mutual Research Corporation (FM) as safe for use in Class I, Division 1, Groups A, B, C and D hazardous atmospheres. Similar foreign certifications have been obtained, including BASEEPA. Special restrictions must be strictly adhered to, to ensure the certification is not invalidated by actions of operating or service personnel.

All flame ionization hydrocarbon detectors are potentially hazardous since they use hydrogen or hydrogen mixtures in the detector cell. Mixtures of hydrogen and air are flammable over a wide range of concentrations whether an inert gas such as nitrogen is present or not. Therefore, the recommended precautions and procedures should be followed for maximum safety. Safety considerations were a major factor in the design of the Organic Vapor Analyzer (OVA).

All connections are of the permanent type as opposed to quick disconnect. To protect against external ignition of flammable gas mixtures, the flame detection chamber has porous metal flame arrestors on the sample input and the exhaust ports as well as on the hydrogen inlet connector. The standard battery pack and other circuits are internally current limited to an intrinsically safe level.

! WARNING

No Modifications Permissible

It is imperative that operation and service procedures described in this manual be carefully followed in order to maintain the intrinsic safety which is built into the OVA. NO MODIFICATION TO THIS INSTRUMENT IS PERMISSIBLE. Therefore, component replacement must be accomplished with approved parts.

Electrical Protection

The 12 V battery power supply circuit is current limited to an intrinsically safe level. Fuses are not utilized and all current limiting resistors and other components which are critical to the safety certification are encapsulated to prevent inadvertent replacement with components of the wrong value or specification. Under no circumstances should the encapsulation be removed.

Fuel Supply System

The OVA fuel tank has a volume of approximately 75 mL which, when filled to the maximum rated pressure of 2300 psig, holds approximately 5/8 ft^3 of gas. The fuel used in the OVA should be PREPURIFIED or ZERO grade hydrogen (certified total hydrocarbons as methane <.5 ppm recommended.)

Hydrogen gas gains heat when expanding and, therefore, should not be rapidly released from a high pressure tank to a low pressure environment. Flow restrictors are incorporated in the hydrogen refill fitting and hydrogen is restricted on the output side of the tank by the low flow rate control system. In addition, a special flow restrictor is incorporated in the FILL/BLEED valve of the hydrogen filling hose assembly. These precausions limit the flow rate of the hydrogen to prevent ignition due to self-heat from expansion.

Precautions should be taken during hydrogen filling or hydrogen emptying operations to ensure that there are no sources of ignition in the immediate area. Since the instrument tank at 2300 psig holds only 5/8 ft^3 of hydrogen, the total quantity, if released to the atmosphere, would be quickly diluted to a non-flammable level. There is, however, the possibility of generating flammable mixtures in the immediate vicinity of the instrument during filling or emptying operations if normal care is not exercised.

Detector Chamber

The input and output ports of the flame ionization chamber have sintered metal flame arrestors. The chamber is ruggedly constructed of Teflon such that even if highly explosive mixtures of hydrogen and air are inadvertently created in the chamber and ignited, the chamber would NOT rupture.

MAINTENANCE

This section describes the routine maintenance schedule and provides procedures for trouble-shooting an instrument malfunction.

CAUTION: Maintenance personnel should be thoroughly familiar with instrument operation before performing maintenance. It is essential that all portions of this manual relating to safety of operation, servicing and maintenance, be thoroughly understood. There should be no potential igniters or flame in the area when filling, emptying or purging the hydrogen system and the instrument should be turned off.

Extreme care should be exercised to ensure that required parts replacement is accomplished with the parts specified by Foxboro. NO MODIFICATIONS ARE PERMITTED. DISASSEMBLE INSTRUMENT ONLY IN A NON-HAZARDOUS ATMOSHPERE.

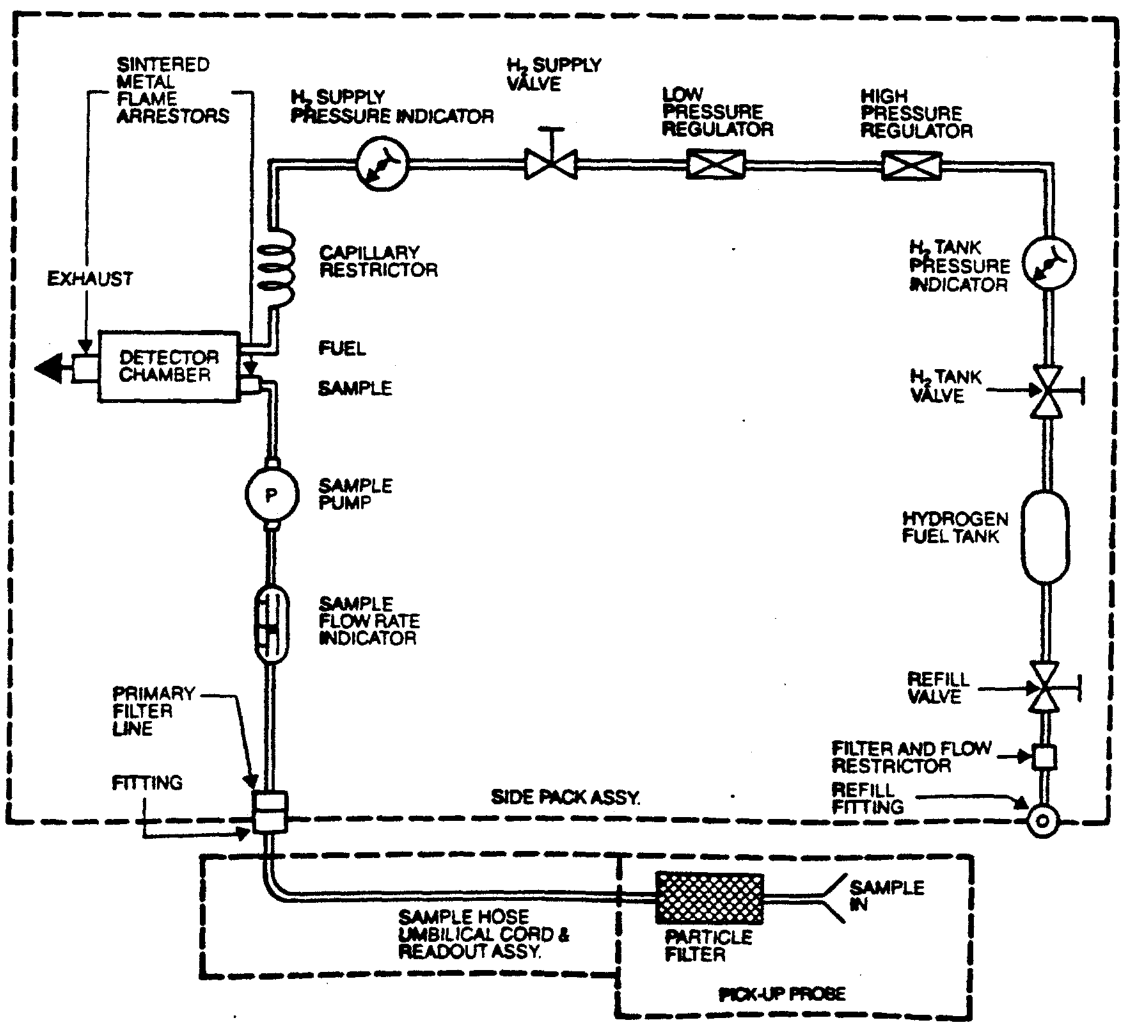


FIGURE 5
BLOCK DIAGRAM - GAS HANDLING SYSTEM

Routine Maintenance (Refer Figure 5)

Primary Filter

This filter is located behind the sample inlet connector (Fitting Assembly) on the Side Pack Assembly and is removed for cleaning by using a 7/16 inch thin wall socket to unscrew the Fitting Assembly. The filter cup, "O" ring and loading spring will then come out. The porous stainless filter cup can be cleaned by blowing out or washing in solvent. If a solvent is used, care should be taken to ensure that all solvent is removed by blowing out or heating the filter. Reassemble in reverse order ensuring that the "O" ring seal on the Fitting Assembly is intact.

Secondary Filter

A particle filter is located in each sampling probe. One of these filters must be in the sample line whenever the instrument is in use. The OVA 108 uses a porous metal filter which can be replaced or cleaned.

Mixer/Burner Assembly Filter

A porous metal particle filter is incorporated in the Mixer/Burner Assembly which screws into the Preamp Assembly. This filter is used as the sample mixer and inlet flame arrestor in the chamber. The filter should not become contaminated under normal conditions but can be cleaned or the assembly replaced if necessary.

Access to this filter or output surface does not require removing the instrument from the case. For access, remove the safety cover using a hex key wrench (supplied) then unscrew the exhaust port. The Filter Assembly can now be seen on the side of the chamber (Preamp Assembly) and can be cleaned with a small wire brush.

Exhaust Flame Arrestor

A porous metal flame arrestor is located in the exhaust port of the detector chamber (Preamp Assembly). It acts as a particle filter on the chamber output and restricts foreign matter from entering the chamber. This filter may be cleaned by removing the exhaust port. For access, see Mixer/Burner section above. Note that the filter is captive to the exhaust port. Clean the filter with a solvent or detergent and ensure that it is dry and completely baked out at 120°F before reinstalling. These filters may also be replaced with new ones (pry out old filter).

Sampling Probes

Sampling probes should be periodically cleaned with an air hose and/or detergent water to eliminate foreign particle matter. If a solvent is used, the fixture should be subsequently cleaned with detergent and baked out at 120°F to eliminate residual hydrocarbons from the solvent.

Hydrogen Tank Supply & Refill Valves

After some time, the Teflon washers under each valve packing nut can "cold flow" (move with pressure) and allow hydrogen to leak. Leakage can be determined by using Leak-Tec, Snoop or a soap solution around the valve stems. This leakage can usually be stopped by tightening the compression nut (adapter) as outlined below.

a) Unscrew the packing nut with a 7/16 inch wrench
b) Unscrew the valve
c) Replace the compression rings

This compression is against soft material and only a small amount of force is necessary to sufficiently compress the Teflon washers. If, after tightening, leakage still occurs, it would be advisable to replace the two Teflon washers, as follows:

a) Drain hydrogen system slowly and to the extent necessary to work on the leaking valve(s). Observe safety precautions. There should be no potential igniters in the area.

b) Remove all three (3) knob screws and knobs.

c) Remove the compression nut on the valve that is not sealing properly. Remove the stem by unscrewing it from the valve body. Observe the sandwich of metal and Teflon washers and note their order.

d) Visually check the Kel-F™ seat on the stem for cracks or foreign material. Wipe clean, if necessary, with a lint free cloth (no solvents or oils) and replace if damaged.

e) Remove the washers and replace the Teflon washers (the factory procedure is a light wipe of HYDROCARBON FREE silicone grease).

f) Replace the stem assembly in the valve body and tighten lightly.

g) Push the washers down into the compression area in the same order as noted upon removal. Replace the compression nut and tighten snuggly.

h) Close the low pressure valve and fill the tank assembly. Check valves for leaks. Tighten again, if necessary, and reassemble the unit.

Another possible cause of contamination is the Mixer/Burner Assembly when the contamination is trapped in the porous bronze sample filter. This is not a common problem and usually only happens when an unusually high level of contaminant is drawn into the assembly. Another possible cause of high background reading is contamination in the air sample line to the detector. This is uncommon but can be the source of the problem.

Analysis and Correction

Prior to analyzing the problem, the OVA should be checked for proper electronic operation. It should be ensured that the instrument is calibrated to methane as referenced.

If, after checking that the OVA is properly calibrated, the background is still higher than normal for ambient conditions, the following procedure should be followed to isolate the cause of the problem:

a) Let the OVA run for a period of time (15 to 30 minutes) and see if the background level decreases as a function of time. The background could go down as a result of clearing line contamination which is removable simply by the normal flow of air through the sample line.

b) Take a reading in a known, relatively clean air environment. Normally, outside air environment is clean enough to assess by comparison whether the background reading is internal to the instrument or is present in the location where the instrument is being used.

c) If the OVA has the Gas Chromatograph Option, depress the sample inject valve, so that the activated charcoal is in the line, and observe whether the background reading goes down and stays steady after elution of the air peak. The reading should always go down or stay the same but never increase when the sample valve is depressed, since the charcoal filter will remove trace elements of organic vapors in the air sample heavier than C_2. If another activated charcoal filter is available, this may be attached to the end of the probe to scrub the air so that a clean air sample is supplied to the detector. The external activated charcoal filter can be used on any instrument, with or without chromatograph, for providing a clean air sample to assess background level.

d) If the background cannot be reduced by any of the previous steps, remove the safety cover and the exhaust port of the detector chamber (on the bottom of the case) and clean the cavity and the electrode using the small wire brush supplied with the analyzer. This will remove small quantities of contamination which could be the source of the background vapor. After cleaning, replace the exhaust port and safety cover and reignite the OVA. If detector contamination was the cause, the problem should be immediately resolved and the ambient back ground will drop to an acceptable level.

e) If the high background is still present, the various parts of the sample flow line such as sampling probes, umbilical cord to the instrument, etc., should be investigated by the process of elimination to see if the contamination can be isolated.

Serious contamination in the air sample line is very uncommon, however, if very large doses of low vapor pressure compounds are sampled, there is a possibility of residual contamination. This would eventually clear itself out but may take a considerable period of time. A typical cause for high background from the sample line is a contaminated Mixer/Burner Assembly. If heavy contamination of the Mixer/Burner is indicated, replace the Mixer/Burner Assembly.

f) In the event of contamination in the pump or other internal parts of the sample flow lines which cannot be removed, the sample flow components have to be disassembled and cleaned. This is normally a factory operation, however, components such as the pump can be replaced in the field along with any contaminated tubing.

g) High background readings on OVA's which include the Gas Chromatograph Option can be caused by other sources of contamination. If the charcoal filter mounted on the instrument panel <u>is</u> saturated, contaminated air would be supplied to the detector and raise the ambient level background. To check for this, refill the cartridge with fresh charcoal, Foxboro P/N CSC004. This would determine if the charcoal was the source of the background reading. It is also possible that a high background reading could be due to contamination in the column. This could be caused by compounds slowly eluting from a column which has become contaminated. The easiest way to check for column contamination is to replace the column with a clean column or a short empty piece of column tubing and see if the high background reading drops.

h) If the above steps do not correct the high background, the cause will normally be contamination in the hydrogen fuel system.

Contamination in the hydrogen fuel system is usually the direct result of contaminated hydrogen gas or contamination introduced during the filling operation. Filling hose contamination can be caused by storing the hose in a contaminated area.

To remove contamination, the fuel system should be purged with hydrogen. Effective purging is accomplished by disconnecting the capillary tube fitting to the manifold block which has the low pressure gauge (Hydrogen Supply Pressure Gauge and Hydrogen Supply Valve). This disconnects the capillary tubing from the hydrogen line so that hydrogen may be purged at a reasonable rate from the tank assembly through the regulators, gauges and valves. After disconnecting the capillary, the hydrogen tank can be filled in the normal manner. The tank valve and hydrogen supply valve can then be opened which will bleed the hydrogen from the tank through the hydrogen fuel system, purging contamination which is in vapor form. There is the possibility that contamination has been introduced into the hydrogen fuel system which is not readily purged by the hydrogen gas, but this is unlikely. After purging with clean hydrogen two or three times, the capillary tube should be reconnected and the background again checked. Five or ten minutes should be allowed before assessing the background reading, since contaminated hydrogen can be trapped in the capillary tube.

If another clean instrument is available, the fuel system from the clean instrument can be connected to the contaminated instrument to verify whether the problem is associated with the hydrogen fuel supply system. The interconnection should be made to the capillary tube of the contaminated instrument.

Troubleshooting

Table 1 presents a summary of field troubleshooting procedures. If necessary, the instrument can be easily removed from the case by unlocking the four (4) ¼ turn fasteners on the panel face, removing the refill cap and ignitor cover. The battery pack is removed by taking out the four (4) screws on the panel and disconnecting the power connector.

Factory Maintenance

To ensure continuous trouble-free operation, a periodic factory maintenance, overhaul, and recalibration is recommended. The recommended schedule is every six to nine months. This maintenance program includes replacement of plastic seals and parts as required, pump overhaul, motor check, sample line cleaning, hydrogen leak check, recalibration, and detailed examination of the unit for any other required maintenance and repair.

Recommended Spare Parts

Item	Description	Part Number	Recommended Quality
1	Igniter	510461-1	2
2	Pump Assembly	510223-6	1
3	Cup, Particle Filters	620090 (5/pkg.)	1
4	Mixer/Burner Assembly	510513-1	1
5	Wafer, Teflon, H_2 Valve	CR007KA (12/pkg.)	1
6	Washer, Brass, H_2 Valve	CR007KB (12/pkg.)	1
7	Exhaust Port Assembly	510530-1	1
8	Battery Pack Assembly	510542-1	1
9	Sample Line Assembly	510316-1	1

TABLE 1

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
1) Low sample flow rate on flow indicator. Nominally 2 units on flow gauge. (See also 5 below)	a) Check primary filter in sidepack and particle filters in the pickup assembly.	Replace or clean filter if clogged.
	b) Determine assembly containing restriction by process of elimination, i.e., remove probe, remove Readout Assembly, remove primary filter, etc.	Investigate the assembly containing this restriction to determine cause of blockage. Clean or replace as required.
	c) If the restriction is in the Side Pack Assembly, further isolate by disconnecting the sample flow tubing at various points, i.e., pump output chamber, etc. NOTE: The inherent restrictions due to length of sample line, flame arrestors, etc., must be taken into account when troubleshooting.	If in the detector chamber, remove and clean or replace porous metal flame arrestors. If pump is found to be the problem, remove and clean or replace.
2) Hydrogen flame will not light. (See also 5 below)	a) Check sample flow rate (see 1 above).	If sample flow rate is low, follow procedure 1 above.
	b) Check igniter by removing the chamber exhaust port and observing the glow when the IGNITE BUTTON is depressed.	If igniter does not light up, replace the plug. If igniter still does not light, check the battery and wiring.
	c) Check for rated Hydrogen Supply Pressure. (Listed on calibration plate on pump bracket).	If low, remove battery pack and adjust to proper level by turning the allen wrench adjustment on the low pressure regulator cap.
	d) Check hydrogen flow rate by observing the psi decrease in pressure on the Hydrogen Tank Pressure gauge. The correct flow rate will cause about 130 psi decrease in pressure per hour. (Approximately 12 mL/min at detector).	The most likely cause for hydrogen flow restriction would be a blocked or partially blocked capillary tube. If flow rate is marginally low, attempt to compensate by increasing the Hydrogen Supply Pressure by one-half or one psi. If flow rate cannot be compensated for, replace capillary tubing.
	e) Check all hydrogen plumbing joints for leaks using soap bubble solution. Also, shut off all valves and note pressure decay on hydrogen tank gauge. It should be less than 350 psi per hour.	Repair leaking joint.

TABLE 1

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
	f) Check to see if hydrogen supply system is frozen up by taking unit into a warm area.	If there is moisture in the hydrogen supply system and the unit must be operated in subfreezing temperatures, purge the hydrogen system with dry nitrogen and ensure the hydrogen gas used is dry.
	g) Remove exhaust port and check for contamination.	If the chamber is dirty, clean with ethyl alcohol and dry by running pump for approximately 15 minutes. If hydrogen fuel jet is misaligned, ensure the porous metal flame arrestor is properly seated.
	h) Check spacing between collecting electrode and burner tip. Spacing should be 0.1 to 0.15 inches.	Adjust by screwing Mixer/Burner Assembly in or out. This spacing problem should only occur after assembling a Mixer/Burner Assembly to a Preamp Assembly.
3) Hydrogen flame lights but will not stay lighted.	a) Follow procedures 2(a), (c), (d), (e), (g), and (h) above.	
4) Flame-out alarm will not go on when hydrogen flame is out.	a) Check instrument calibration setting and GAS SELECT control setting.	Readjust as required to proper setting. Note that the flame-out alarm is actuated when the meter reading goes below zero.
	b) Remove exhaust port and check for leakage current path in chamber (probably moisture or dirt in chamber).	Clean contamination and/or moisture from chamber using a swab and alcohol, dry chamber by running pump for approximately 15 minutes.
	c) If above procedures do not resolve the problem, the probable cause is a malfunction in the preamp or power board assemblies.	Return preamp chamber or power board assembly to the factory for repair.
	d) Check that volume control knob is turned up.	Adjust for desired volume.

TABLE 1

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
5) Slow response, i.e., time to obtain response after sample is applied to input is too long.	a) Check to ensure that probe is firmly seated on the rubber seal in the readout assembly.	Reseat by holding the probe firmly against the rubber seat and then lock in position with the knurled locking nut.
	b) Check sample flow rate per procedure 1 above.	See 1 above.
6) Slow recovery time, i.e. too long a time for the reading to get back to ambient after exposure to a high concentration of organic vapor.	a) This problem is normally caused by contamination in the sample input line. This requires pumping for a long period to get the system clean of vapors. Charcoal in the lines would be the worst type of contamination. Isolate through the process of elimination. (See 1(b)).	Clean or replace contaminated sample line or assembly as required.
	b) Check flame chamber for contamination.	Clean as required.
7) Ambient background reading in clean environment is too high.	a) A false ambient background reading can be caused by hydrocarbons in the hydrogen fuel supply system. Place finger over sample probe tube restricting sample flow and if meter indication does not go down significantly the contamination is probably in the hydrogen fuel.	Use a higher grade of hydrocarbon free hydrogen. Check for contaminated fittings on filling hose assembly.
	b) A false ambient background reading can also be caused by a residue of sample building up on the face of the sample inlet filter. If the test in 7(a) above produces a large drop in reading, this is usually the cause.	Remove the exhaust port (it is not necessary to remove instrument from case). Use the small wire brush from the tool kit or a knife blade and lightly scrub surface of sample inlet filter.
	c) A false ambient background reading can also be caused by hydrocarbon contamination in the sample input system. The most likely cause would be a contaminant absorbed or condensed in the sample line. NOTE: It should be emphasized that running the instrument tends to keep down the buildup of background vapors. Therefore, run the unit whenever possible and store it with the carrying case open in clean air.	Clean and/on replace the sample input lines. Normally the false reading will clear up with sufficient running.

TABLE 1

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
8) Pump will not run.	a) Check that there is no short circuit in wiring.	If no short circuit, pump motor is defective.
9) No power to electronics but pump runs.	a) Short circuit in electronics.	There is a short in the electronics assembly. Return OVA to factory or authorized repair facility.
10) No power to pump or electronics	a) Place battery on charger and see if power is then available. Recharge in a non-hazardous area only.	If power is available, battery pack is dead or open. Recharge battery pack. If still defective, replace battery pack.

Sample Loop Replacement

The Gas Chromatograph (GC) option is equipped with a variable loop sample valve. Included with the instrument are sample loops for sample volumes of 0.25, 1.0 and 2.5 cc.

The minimum sample loop volume is approximately 0.25 cc, which will enable sample injection without flameout. When a sample loop larger than 0.25 cc is installed, flameout will occur after sample injection and reignition will be required. The period of time between sample injection and when reignition can be accomplished is dependent on the sample loop volume and column length. Increasing the volume of the sample loop or increasing the column length will increase the waiting period for reignition. As an example: with a 2.5 cc loop and a 24 inch column, approximately 20 seconds must elapse prior to reignition. The waiting period is to allow the air sample to elute from the column.

Standard size sample loops may be purchased or loops may be made by the customer. The sensitivity of the OVA is directly related to the sample loop volume. Sample loops up to 3.0 cc have been used successfully.

It should be noted that rapid analysis columns (typically less than 45 seconds retention time) may have to be lengthened to enable reignition when using large volume sample loops.

Sample Loop Installation Procedure

1. Remove OVA from sidepack case.
   - A. Remove exhaust cover and exhaust port assembly.
   - B. Remove Hydrogen refill cap.
   - C. Loosen four 1/4-turn fasteners.
   - D. Remove ignitor protector.
   - E. Lift out of case right side first.
2. The sample loop is now accessible from the back of the instrument directly beside the H refill valve.
3. Remove existing loop using a 7/16 inch open-end wrench.
4. Select desired sample loop and attach one end to the bottom fitting. Tighten securely. On loops longer than 2 inches, it is recommended to wrap the tubing around the lower end of the H cylinder. Attach other end of loop to top fitting. Tighten securely.
5. Press inject valve in the "down" position. Open H supply valve and leak check around fittings with soap solution (e.g., snoop).
6. Replace OVA in its case, fasten four 1/4-turn fasteners, and replace exhaust assembly refill cap and ignitor protector.
7. The instrument is now ready for operation.

GAS CHROMATOGRAPH (GC) OPTION

The Model OVA 108 CENTURY Organic Vapor Analyzer provides efficient and accurate indication of total organic compound concentrations on a continuous sampling basis. However, in areas where mixtures of organic vapors are present, it often becomes necessary to determine the relative concentration of the components and/or to make quantitative analysis of specific compounds.

To provide this capability, a gas chromatograph (GC) option is available. See Figure 6 for the location of the major components and controls associated with the GC option. When the GC option is used, the capability of the OVA includes both qualitative and on-the-spot quantitative analysis of specific components present in the ambient environment. The Recorder, which is used with the GC option, is described separately.

This section is applicable only to an OVA with the optional gas chromatograph system.

Modes of Operation

The OVA with GC option has two modes of operation. The first mode is the measurement of total organic vapors in the same manner as described for the basic OVA instrument. This mode is referred to as the "Survey Mode". The OVA is in the "Survey Mode" of operation whenever the Sample Inject Valve is in the "out" position.

The second mode of operation is called the "GC Mode". The OVA is in this mode of operation any time a sample has been injected into the GC system and the sample is being transported through the GC column. This section provides a brief description of how a gas chromatograph (GC) operates and specifically, how the model OVA 108 performs the required operations. A comprehensive discussion of gas chromatography theory, column selection, and data analysis is beyond the scope of this manual.

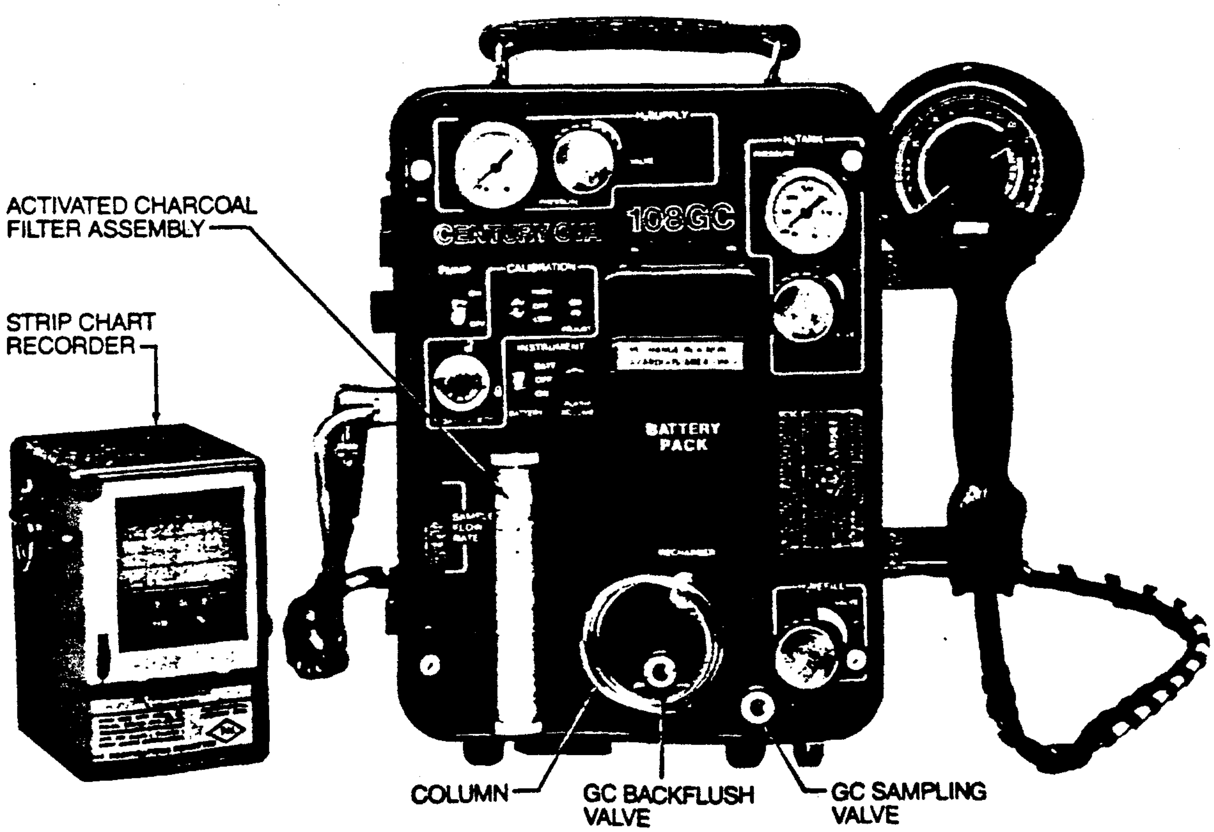


FIGURE 6
ADDITIONAL CONTROLS & COMPONENTS - GC OPTION

The OVA with GC option can be utilized for many types of analysis in the outdoor or indoor ambient environment or for specific laboratory type analysis. The OVA was not designed to compete with the research or process gas chromatograph but to compliment these instruments or eliminate their need in filed applications.

This manual is intended to provide the operator with information to operate and maintain the OVA. Foxboro publishes Application/Technical Notes to assist the operators in applying the instrument to field monitoring situations.

All flame ionization detector (FID) gas chromatographs require certain elements for their operation. These elements include three flow regulated gas supplies as follows: 1) A carrier gas to transport the sample through the column; 2) Hydrogen gas for operation of the FID; 3) A clean air supply to support combustion to the FID. In addition, a method for injecting a known volume of sample air (aliquot) to be analyzed is required.

In standard gas chromatographs these three (3) flow regulated gases are individually supplied from pressurized cylinders equipped with regulators and flow control apparatus. The Model 108 GC system differs in that the hydrogen fuel for the FID is also used as the carrier gas. The clean air supply is simply the normal air sample pumped to the FID. During the GC analysis, this air is scrubbed in a charcoal filter to provide the clean air supply. The end result is that no additional gas supplies are required to add the GC option to the basic OVA instrument.

A valving arrangement is incorporated to provide a method for transferring a fixed volume of air into the GC system for analysis. The sample air injected into the GC column is the same sample being analyzed by the OVA for total organic vapor concentration. Therefore, the instrument provides the unique capability to observe the total organic vapor concentration of the sample prior to injecting it into the GC system. This operating feature is invaluable in field work where the environment is continually changing and where valuable GC analysis time must be expended only on the sample of concern.

OVA Columns

Columns are available in 4, 8, 12, 24, 36 and 48 inch lengths as standard offerings with any of the column packings listed below. Longer lengths are available in 12-inch increments on a available basis. To order a column simply use the general part number for a column which is 510454 followed by a dash (-), the Foxboro packing material designation, a second dash and the desired length in inches. A sample column designation is 510454-G-24. This would represent a 24 inch column with 10% OV 101 on chromosorb W, HP 60/80 mesh. If a specific application arised which calls for a column material not listed below, please contact Foxboro. We will be happy to check on its availability.

Foxboro Designation	Material
A	20% Dioctyl Phthalate on Chromosorb-P, AW 60/80 Mesh
C	Chromosorb 101, 60/80 Mesh
D	20% Ucon 50 HB 280 on Chromosorb-P, AW 60/80 Mesh
E	20% Carbowax 400 on ChromosorbP, AW 60/80 Mesh
F	5/1.75% Diethylhexyl Sebecate/Bentone 34 on Chomosorb W, AW 60/80 Mesh
G	10% OV-101 on Chromosorb W, HP 60/80 Mesh
T	10% 1,2,3-Tris (2-cyanoethoxy) Propane on Chromosorb P, AW 60/80 Mesh
B	3% Diisodecyl Phthalate on Chromosorb W, AW 60/80 Mesh
PT	Poropak T, 60/80 Mesh
Q	Poropak Q, 60/80 Mesh
H	20% Carbowax 20M on Chromosorb P, Aw 60/80 Mesh
J	n-Octane on Porasil C, 80/100 Mesh
N	Porapak N, 60/80 Mesh

Sample Flow

Figure 7 is a flow diagram illustrating the flow paths of the hydrogen fuel, sample air supply, and GC injected sample aliquot.

Two push-pull valves are used in the GC system; the Sample Inject Valve and the Backflush Valve.

Block D illustrates the flow paths with the Sample Inject Valve in the "out" position. With this valve in the "out" position, the OVA functions in its normal manner as a total organic vapor analyzer.

Block C illustrates the flow paths after the Sample Inject Valve is moved to the "in" position to initiate the GC Mode.

The hydrogen flow path is now through the sample loop which enables hydrogen to sweep the air sample from the loop and carry it through the GC column.

Also note that the sample air going to the FID chamber is now routed through the activated charcoal filter where essentially all organic vapor contamination is removed from the air. The activated charcoal filter will effectively absorb most organic vapors with the exception of methane and ethane. The functions of the Sample Inject Valve are, therefore, to transfer a fixed volume sample of the air being monitored into the hydrogen stream and to reroute the sample air supply through a filter (scrubber).

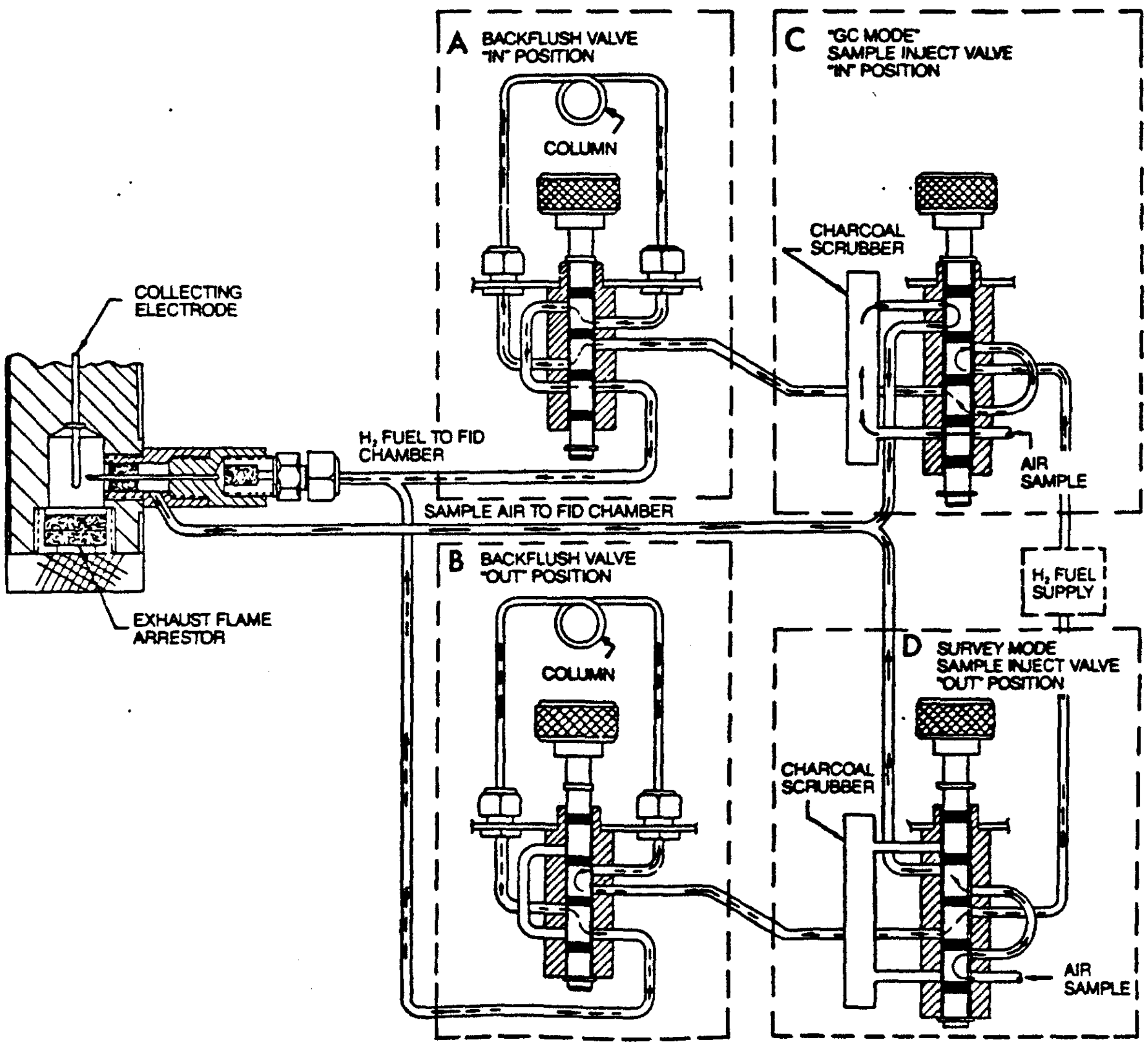


FIGURE 7
FLOW DIAGRAM - GC OPTION

The Backflush Valve has no prepositioning requirement to function. It can be in either the "in" or "out" position at the time a sample is injected into the GC system for analysis. The Backflush Valve simply reverses the direction of the hydrogen flow through the GC column.

Regardless of the operating mode, hydrogen always flows through the column to the FID detector and the sample air supply always flows to the FID detector to provide oxygen for the hydrogen flame.

The recommended hydrogen flow rate is 12 mL/min for proper FID operation and as a standard flow rate for generating GC reference/calibration data. This hydrogen flow rate is adjusted by varying the Hydrogen Supply Pressure, which is the hydrogen pressure at the input of the flow control capillary tube of the OVA. The pressure is changed by adjusting the set screw in the bonnet of the low pressure regulator, accessible by removing the battery pack from the instrument panel. To monitor the hydrogen flow rate, connect a bubble flowmeter to an end of the GC column which has been disconnected from the panel fitting and move the Backflush Valve so that hydrogen is flowing out of the column. Primary hydrogen flow control is accomplished by the capillary tube of the OVA. However, the flow restriction of a GC column will also affect the hydrogen rate and the effect will vary with column length, type of packing and packing methods. The nominal Hydrogen Supply Pressure is around 10 psig and the pressure drop across a typical 24 inch long column packed with 60/80 mesh material is approximately 1 to 1.5 psig. Normally, when the hydrogen flow rate is set at 12 mL/min with a standard 24 inch long column, no adjustment needs to be made when using columns from four (4) inches to four (4) feet long. Longer columns may require hydrogen flow adjustment would be required if and when precisely controlled analysis was being conducted or when the hydrogen flow was too low to keep the flame burning.

The sample air flow rate is not adjustable and is nominally 1.5 - 2.5 liter/minute. This flow rate should remain relatively constant. A sample flow gauge is provided on the OVA panel to monitor the sample flow rate. (Note: Panel gauge is not calibrated in L/min). When the Sample Inject Valve is in the "in" position, there may be a slight increase or decrease in sample air flow rate (0 to 15%). This change will normally not affect operation of the instrument as long as the flow rate is consistent from analysis to analysis. Basically, if the flow rate is consistent between calibration and end usage, there will be suitable precision in the measurements.

GC Analysis

1) **SAMPLE INJECTION**

When the Sample Injection Valve is depressed, the air in the sample loop is injected into the hydrogen stream which transports the sample through the column for separation of its components and to the flame chamber for analysis. This small volume of injected sample is qualitatively analyzed based on the retention time of the individual components of that sample while passing through the column. Quantitative analysis can then be accomplished by peak height or peak area analysis methods.

2) **THE COLUMN**

The column consists of tubing packed with a material which physically interacts with organic vapors and retards the passage of the vapors through the column. Since the packing material has a different attraction for each organic substance, each component in a mixture of gases will be slowed down to a different extent.

The net effect is that each component elutes from the column at a different time. The components are then fed to the detector which gives a response to the meter or to an external strip chart recorder.

A portable isothermal pack (PIP) can be used for temperature control and/or isothermal analysis. This is described further under PIP kit option.

3) **QUALITATIVE ANALYSIS**

As each organic substance has a unique interaction with the column packing material, the time that the substance is retained on the column is also unique and thus characteristic of that particular substance. The "retention time" (RT) is primarily dependent on the type of packing material, the length of the column, the flow rate of the gas carrying the mixture through the column and the temperature range of the system.

When these variables are controlled, the retention times can be used to identify each of the components in a mixture. Because of these variables, it is usually necessary to establish retention times for each instrument by making a test with the pure substances of interest or to refer to established time data charts prepared in advance for that specific instrument. In those cases where retention times of the components are too close together for a good analysis, an adjustment in one or more of the operating variables will effect a sufficient difference in retention times to enable meaningful analysis.

4) QUANTITATIVE ANALYSIS

The detector response to any organic component is proportional to the quantity of material passing through the detector at a given time. For an eluted component, a plot of concentration vs. time forms a bell-shaped curve.

When using a strip chart recorder, the curve drawn on the paper is triangularly shaped and the area under the peak is related to the amount of substance being analyzed.

5) BACKFLUSH

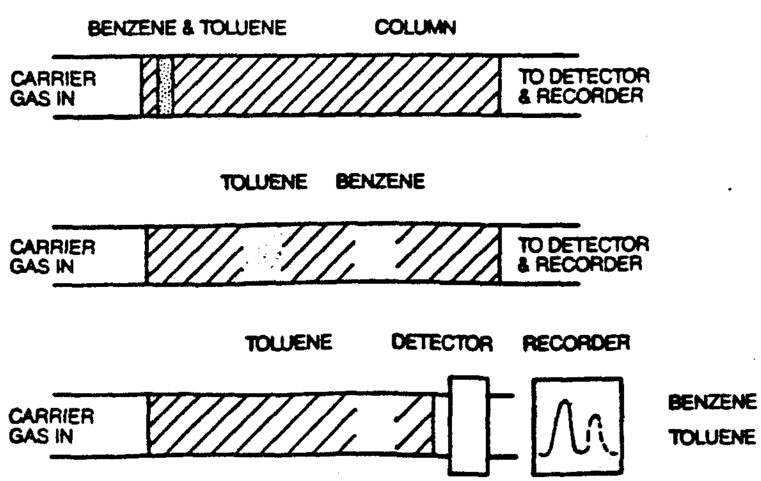
The column Backflush Valve is provided to reverse the flow of the carrier gas (hydrogen) through the column. It is necessary that the column be backflushed after each individual analysis except under certain special conditions. The primary purpose of the backflush function is to clear the column of heavy compounds (with long retention times) which would contaminate the column and cause interferences to future GC analysis. The Backflush Valve has no prepositioning requirement; it is reversed from either position it was in during GC analysis. The Backflush Valve should be actuated immediately after the peak of the last compound of interest elutes. Figure 8 illustrated the function of the Backflush Valve.

In the GC system, the backflush is "to the detector". This is possible because the carrier gas and detector fuel are the same, i.e., hydrogen. It provides a convenient means of quantifying the total compounds in the backflush by simply recording the peak that elutes during the backflush operation. For field instruments, this quantitative backflush information is valuable since it provides a direct means of observing the condition of the column and seeing when the column is clean and the detector response has returned to baseline. The time required for the backflush is usually 1.2 to 1.5 times the GC analysis time.

6) SURVEY TO GC MODE

There is an inherent advantage to integrating the GC system to the basic total Organic Vapor Analyzer (OVA). The OVA provides a direct reading of total organic vapors in the air being sampled, which gives the operator information about the sample being injected into the GC system. This information can be used to predict and verify the peaks that result during the GC analysis, including the backflush peak.

This feature eliminates expending valuable GC analysis time where there is no contamination of concern (comparable to taking noise measurements in quiet corners). It also enables the operator to select the most appropriate location to conduct an analysis, normally the area of highest concentration.



PICTORIAL SEPARATION OF BENZENE AND TOLUENE—"A" AT BEGINNING OF SEPARATION; "B" DURING SEPARATION; "C" BENZENE HAS ALREADY PASSED THE DETECTOR AND IS RECORDED. TOLUENE (DOTTED LINES) WILL APPEAR ON RECORDER AS IT PASSES THE DETECTOR.

FIGURE 8
TYPICAL COLUMN SEPARATION SEQUENCE

GC MODE OPERATING PROCEDURES

The gas chromatographic analysis mode (GC Mode) of operation can be initiated at any time during a survey by simply depressing the Sample Inject Valve. After completion of the analysis and backflush operations, the Sample Inject Valve is pulled out and the survey continued or another sample injected. Note that when the Sample Inject Valve is in the survey mode (out position) the OVA operates in the same manner as an OVA which does not incorporate the GC option.

Controls/Indicators

Refer to Figure 6.

1) Sample Inject Valve - This two (2) position valve (shown schematically in Figure 7) is used to select either Survey Mode (valve out) or GC Mode (valve in).

2) Backflush Valve - This two (2) position valve (shown schematically in Figure 7) is used to reverse the flow of hydrogen through the column to:

   a) Backflush the column for cleaning.

   b) Quantitatively measure total compounds after a selected point. Example: Separation of methane from nonmethane hydrocarbons to read total non-methane hydrocarbon level.

3) Column - Separates components of a gas mixture so that each component of the mixture elutes from the column at a different time.

4) Activated Charcoal Filter Assembly - This assembly functions only in the GC Mode (Sample Inject Valve "in") as shown schematically in Figure 7). It removes organic compounds (except methane and ethane) by absorption from the sample air supply.

Turn on Procedure

Place the Sample Inject Valve in the "out" position and put the OVA instrument in operation per "Operating Procedures" for the survey mode. NOTE: Leave the hydrogen fuel and pump "on" for three (3) to four (4) minutes before attempting ignition to allow time for hydrogen purging of the column.

Survey Mode

When using the OVA in the Survey Mode, endure that the Sample Inject Valve remains in the full "out" position and that the Backflush Valve is either full "in" or full "out". Note that when changing from the GC Mode to the Survey Mode, the OVA output reading will continue to change until all compounds have been eluted from the GC column. Therefore, under normal field conditions, the GC column should be backflushed for clearing, which takes approximately 1.2 to 1.5 times the forward analysis time. The backflush peak may be observed returning to baseline, after which the Sample Inject Valve may be moved to the survey Mode (out) position.

When the compound (s) being analyzed are known to be the only compound(s) present in the air sample, backflushing may be omitted.

GC Mode Operation

In normal GC analysis, a strip chart recorder is used to record the output concentration from the OVA as a function of time. This record, called a chromatogram, is utilized for interpretation of the GC data.

a) OPERATION

   1) Turn on recorder and push Sample Inject Valve "in" with a fast, positive motion. This starts the GC analysis which is automatic up to the point of backflushing. NOTE: Rapid and positive motion should be used when moving either the Sample Inject or Backflush Valves. On occasion, the flame in the FID detector may go out, which would be indicated by a sharp and continued drop of the concentration level. If this occurs, reignite the flame and continue the analysis. NOTE: A negative "air" peak typically occurs shortly after sample injection and should not be confused with flame-out.

   2) The negative air peak and various positive compound peaks indicated on the OVA readout meter and the strip chart recorder represent the chromatogram.

3) After the predetermined time for the analysis has elapsed (normally immediately after the peak of the last compound of concern), rapidly move the Backflush Valve to its alternate position (in or out). Leave the instrument in this condition until the backflush peak returns to baseline, then pull the Sample Inject Valve out after being in the backflush condition for a period at least twice as long as the analysis time. The OVA is now in the Survey Mode and ready for survey or injection of another sample into the GC system.

b) INTERPRETATION OF RESULTS

The OVA 108 with GC option is intended for applications where there are a limited number of compounds of interest and the compounds are normally known. Under these conditions, the operator must know the retention time and peak height characteristics of the compounds under specific operating conditions. To calibrate the OVA in the GC Mode, determine, by test, the retention time and peak area (using peak hight analysis) for the compounds of concern. These tests should be conducted on the column to be utilized and over the concentration and temperature range of concern. When representative characteristic data is available, such as in the Application/Technical Notes, a spot calibration check is normally all that is required.

It should be noted that under normal field conditions, the vapor concentrations vary continually as a function of time, location, and conditions. Field measurements for industrial hygene work are normally associated with a threshold level around a preestablished concentration. Surveys for locating fugitive emission sources present a continually varying situation. Under these conditions, it is desirable to have a simple method of interpreting the GC data for on-the-spot analysis and decision making.

High precision is normally not a requirement for these type analyses since the environment is continually changing. The methods presented in this section are designed to provide a means for typical field analysis. When the OVA is used under laboratory conditions, standard laboratory methodology may be used for greater precision.

Technical Discussion

The chromatogram is a chart recorder trace of the organic vapor concentration from the Organic Vapor Analyzer (OVA) as a function of time. A typical chromatogram is illustrated in Figure 9 and is a series of triangular shaped peaks originating from and returning to a fixed baseline. Qualitative interpretation of a chromatogram involves identifying a peak by analyzing the time it took for the peak to appear after initial injection (referred to as retention time (RT)) and comparing this RT to reference data. Quantitative interpretation involves analyzing the area under the peak and relating this area to calibration data of peak area versus concentration for that specific compound under the conditions present during the GC analysis.

It can be seen that interpretation of a chromatogram requires the use of calibration reference data. GC reference data is always generated empirically, i.e., through tests. Foxboro Application/Technical Notes may be used as a reference for selecting columns and intepreting chromatograms. However, simple tests must be conducted to obtain the required reference data.

a) QUALITATIVE ANALYSIS

Under a given set of operating conditions the retention time is characteristic of that particular substance and can be used to identify specific compound. It will be necessary to calibrate retention times by making tests with the pure compounds of interest.

The retention time (RT) is defined as that period of time from injection until the time of maximum detector response for each substance. Retention time is measured from the time of sample injection to the time the apex of the triangle shaped curve is obtained on the strip chart recorder. (See Figure 9). The strip chart recorder operates on a clock mechanism such that the distance along the baseline is proportional to time. While retention times are characteristic for each compound, it is possible that two materials could have the same retention times. Thus, if there is any question as to the identity of the vapor, it may be necessary to verify identification by retention times on different columns.

Use of a longer column will increase the retention times of those components it is capable of separating. The time between peaks will also be increased. This is especially useful if a component comes through too fast or if desired peaks are so close that they overlap.

b) COLUMN SELECTION

Two columns are supplied with the instrument. These are general purpose columns which are useful in a wide variety of applications. If they do not achieve separations for a particular application, it may be necessary to select other packing materials or longer columns. Foxboro will assist in this selection or prepare a custom column if necessary.

If columns are made by the user or purchased from other sources, ensure that the packing density does not create too large a pressure drop. A large pressure drop can result in flame-out problems.

c) TEMPERATURE EFFECT ON RETENTION TIME

An increase in temperature will decrease column retention time (RT) and vice versa. Normally retention time (RT) as a function of temperature, changes linearly over the range of 0 to 40°C. For complex qualitative analysis, a calibration plot of RT versus temperature will be required. In typical usage, such as inside a factory, the effect of temperature can be compensated for during chromatogram interpretation. A single component tracer compound can be sampled at any time to provide a "key" for other compound identification.

d) CARRIER GAS GLOW RATE AFFECT ON RETENTION TIME

An increase in carrier gas glow rate will decrease retention time. For reproducible data, the carrier gas (hydrogen) flow rate must be recorded in association with a chromatogram. Primary control of the hydrogen flow rate

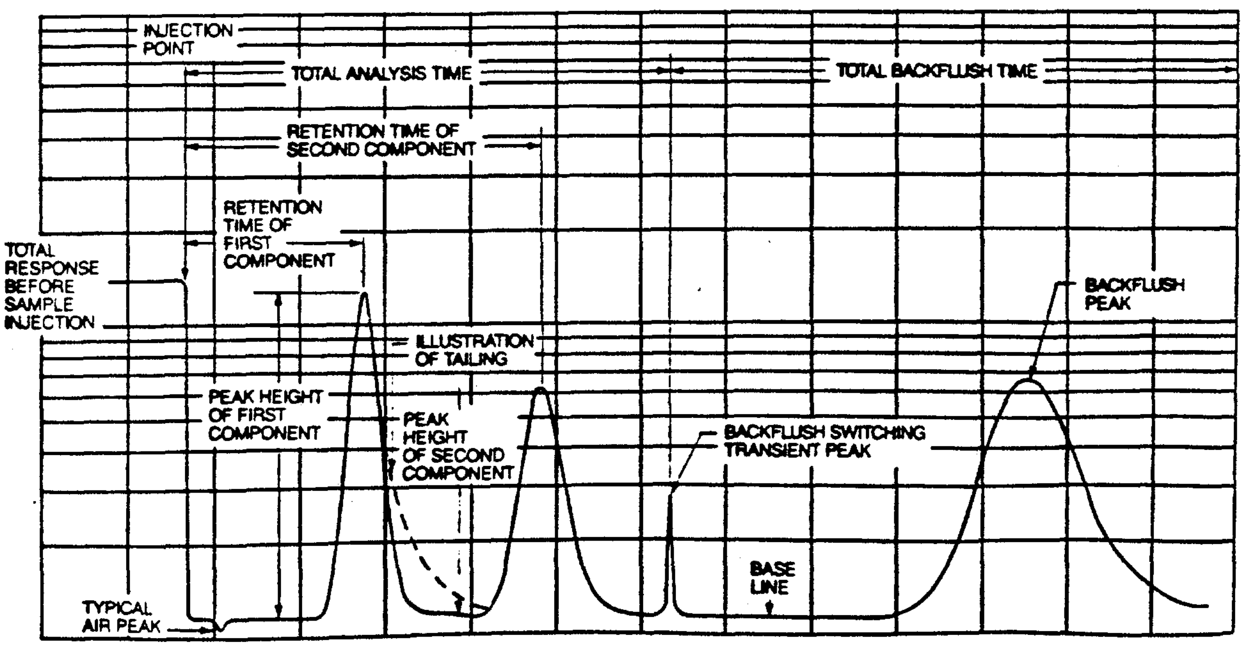


FIGURE 9
TYPICAL CHROMATOGRAM

is accomplished in the OVA by regulating the hydrogen pressure across a capillary tube. The hydrogen flow rate is also affected by the restriction of the GC column but most columns have a limited affect. The hydrogen flow rate is factory set at 12 mL/minute with a typical 24 inch column.

e) QUANTITATIVE ANALYSIS

In general, the more triangularly symmetrical the peak, the better the peak height analysis capability. However, many GC peaks have "tailing" as illustrated in Figure 9. The tailing will become more evident when considering the logarithmic nature of the OVA 108. As the peak elutes the rate at which it is reported will slow down overtime as the concentration valve increases. This has the net effect of rounding the peak apex's slightly and exaggerated tailing. However, peak height calibration is an acceptable method for quantitative analysis as long as the area under the tail is relatively small compared with the total peak area. If severe tailing occurs, empirical calibration data generated through tests may be required to plot the peak height versus the concentration curve.

Only peak height analysis will be discussed in this manual. The method involves injecting a known concentration of the compound and recording the peak height under the test conditions. Peak height characteristics can be established for various columns and various temperatures. Normally, both retention time and peak height characteristics will be measured.

When peak area measurements are desired, the areas may be measured using an integrator on the OVA output signal. Other manual methods may also be used, such as counting squares, weighing curves or simple triangulation. When the GC peaks have good symmentry, triangulation (area equals 1/2 base x height) is a convenient method.

Calibration Data (Refer Figure 10)

When conducting tests to obtain GC calibration data, the following information should be recorded.

a) Column - description and serial number as applicable.
b) Temperature - column temperature, normally room ambient.
c) Chart speed - distance/unit time.
d) Carrier flow rate - hydrogen flow rate through the column (mL/min).
e) Sample concentration - ppm for each compound.
f) Sample volume - OVA by serial number or typically 0.25 mL for standard value.
g) Recorder scaling decade log/ppm relationship.
h) OVA serial number.

To obtain a calibration point, inject a known concentration sample into the GC system and record the resulting chromatogram peak. The retention time for the peak may be scaled from the record or timed with a stop watch. The peak height may be scaled from the record or the OVA readout meter may be observed during the elution of

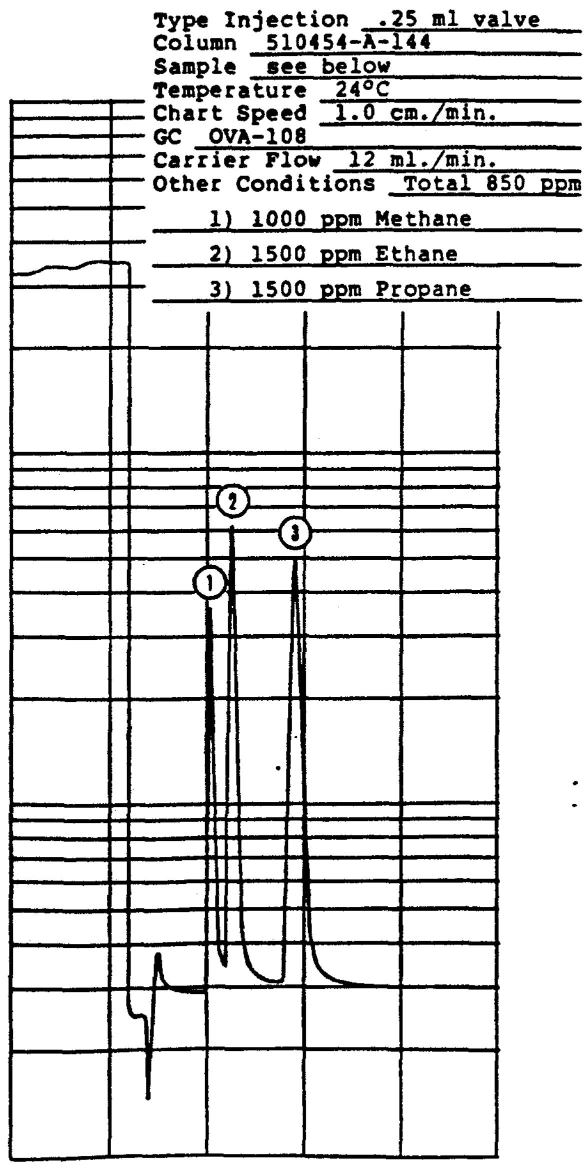


FIGURE 10
CHROMATOGRAM

the peak. A single calibration point, preferable around the concentration of concern, is normally all that is required to plot peak height response in ppm as a function of compound concentration. Data for other compounds on the same column may also be plotted along with their associated retention times, percent relative response in the total organic Survey Mode, TLV, etc. It is recommended that copies of the actual chromatograms be kept with the charts for observing the peak shapes, peak interferences, etc. It should be noted that a chromatogram can be utilized like a fingerprint for compound identification or peak height and shape comparison. Transparent overlays are an aid in chromatogram analysis.

Preparing and using the calibration chart is very straightforward. As an example, once the elution sequence of a group of compounds is determined, a mixture of 100 ppm of each can be prepared and run on the GC for chart data. The retention time of each compound and the peak height of each can be read directly from the chromatogram and the data put on the chart. If temperature data is to be taken, additional chromatograms may be run with the same sample and the RT and peak height as a function of temperature.

When complex mixtures such as gasoline are analyzed, it may be desireable to keep the record of the backflush peak for future reference and peak area comparison. It is also recommended that the total organic vapor concentration reading on the OVA be recorded for each calibration sample used. This reading is used for arriving at relative response numbers and as a check on sample preparation precision.

Routine Maintenance

a) COLUMN

Any column can be contaminated with compounds having long retention times. This will result in high background readings. This condition can be checked by installing a new column or a blank column (tubing only). If this reduces the background reading, the contaminated column should be baked at 100°C (212°F) for three to four hours in a drying oven while passing nitrogen through the column. Higher temperatures may permanently damage the column packing.

When installing any column, avoid touching the ends, as this may cause contamination. Also, ensure that the fittings are tight to avoid hydrogen leakage.

IMPORTANT: The following simple test may be run to determine whether the GC column is contaminated. While in a clean ambient air background, place the Sample Inject Valve in the "in" (GC Mode) position. Observe the background reading on the meter or recorder. After one (1) to two (2) minutes, change the position of the Backflush Valve and again observe the background reading. If the background reading went down and then started to increase in one to two minutes, the column is probably contaminated and needs to be cleaned. Note that if hydrogen flows into one end of the column for a period of time, the contamination is pushed into the column.

Then when the hydrogen flow is reversed, the exhaust end of the column will be clean until the contamination is again pushed through. Remember that to clean a column the purge gas must be run through the column in one direction until all contamination is removed. NOTE: Contaminated columns can be avoided by backflushing the column after every analysis.

b) CHARCOAL FILTER ASSEMBLY

After repeated use, the Charcoal Filter Assembly will become saturated. Periodically, the operator should check the effectiveness of the activated charcoal.

This can easily be done by operating the unit with the Sample Injection Valve "in" and passing the probe near a concentrated sample of the compound being analyzed. The readout should remain nearly steady (should not rise more than 2 parts per million (ppm). If rise is more than 2 ppm, replace the old charcoal with new activated charcoal. Care should be taken to completely fill the tube to prevent a path for sample to bypass the charcoal. The life of the charcoal depends on the time (length) of exposure and the concentration level during that exposure. When changing charcoal, be sure that any fine charcoal dust is removed from the assembly.

Another test of the charcoal filter is to note the background reading with the Sample Inject Valve "out" and then note the reading with the valve "in". The level should never be higher when the valve is in the "in" position and the charcoal filter is in the air line. If the reading with the valve in the "in" position is higher, the charcoal filter is probably contaminated and acting like a contamination emitter.

Troubleshooting

Table 2 presents recommended trouble shooting procedures which are associated with the GC system. These procedures are in addition to those found in the basic OVA section of the manual.

TABLE 2

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
1) Low sample flow rate on flow indicator.	a) Check Teflon tubing on valve assembly for kinks, etc.	Straighten or replace teflon tubing.
	b) Check flow rate with valve in down position.	Check for over restriction of charcoal filter.
2) Hydrogen flame will not light.	a) Check column connections on top of unit to make sure they are tight.	Tighten fittings.
	b) Check column for sharp bends or kinks. (Hydrogen flows through this column at all times and a sharp bend will compact packing too tightly for proper hydrogen flow).	Replace column.
	c) Check charcoal filter fittings to make sure they are tight.	Tighten fittings.
	d) Check hydrogen flow rate from the column.	Adjust hydrogen pressure to obtain 12 mL/min flow rate.
	e) Check that the Inject and Backflush Valves are both completely in or out. A partially activated valve will block the hydrogen and air flow paths.	Ensure both valves are either completely in or out.
	f) If a new column was installed prior to problem identification, check for proper hydrogen flow rate through the column (should be approximately 12 mL/min).	Increase hydrogen pressure to obtain proper hydrogen flow rate or if column is excessively restrictive, replace or repack the column.
3) Ambient background reading in clean environment is too high.	a) Check for contamination in charcoal filter assembly. This can be detected if ambient reading increases when going in to the chromatographic mode.	Replace activated charcoal in charcoal filter assembly.
	b) Check for contamination in column.	Replace or clean column.
	c) Check for contamination in column valve assembly.	Remove valve stems and wipe with clean lint-free cloth. Heat valve assembly during operation to vaporize and remove contaminants.
4) Flame-out when operating either valve.	a) Ensure valves are being operated with a quick, positive motion.	Operate valve with a positive motion.

TABLE 2

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
	b) Either hydrogen or air may be leaking around one or more of the valve quad rings. Assess by tests and "O" ring inspection.	Remove stems and lightly coat with silicone grease, only on contact surface of the "O" ring. Wipe off excess (do not remove quad rings).
	c) Damaged or worn quad rings causing leak.	Replace quad rings and grease as above.
5) Excessive peak tailing	a) Change or clean GC; see if problem disappears.	Ensure columns are clean prior to use. If one of the same type of column tails are worse than others, repack the column or discard.
	b) Inspect GC valves for excessive silicone grease or contamination.	Excessive lubricant or foreign matter in the valve assembly can cause excessive tailing. Clean valve assemblies and lightly relubricate as required. Lubricant should be put only on the outside contact surface of the "O" ring. Do not get grease into the "O" ring grooves.

Recommended Spares

The following spare parts and supplies are recommended to support the GC system and recorder. These are an addition to the spare parts list for the basic OVA described in the "OVA MAINTENANCE" section.

ITEM DESCRIPTION	PART NO.
1) Quad Rings	510496-1 (10/pkg.)
2) Tubing, .148 in ID .020 wall	12942
3) Tubing, Teflon .120 in ID .030 wall	12941
4) Activated Charcoal	CSC-004
5) "O" Ring for Charcoal Scrubber	U0118CE
6) Chart Paper (Logarithmic	CSC-006 (6 rls/pkg)

ACCESSORIES

Recorder Accessory

A portable Strip Chart Recorder is available for use with the OVA (reference Figure 10). The recorder is powered from the OVA battery pack and the output can be scaled to match the OVA readout meter, thereby providing a permanent record for subsequent analysis or reference. P/N 510445-2 is FM certified intrinsically safe. P/N 510445-5 is BASEEFA certified.

The recorder can be used with the OVA to provide a long term monitoring profile of total hydrocarbon or can be used with the Gas Chromatograph Option to provide a chromatogram.

Features

The recorder prints dry (no ink) on pressure sensitive chart paper. The recorder is equipped with two gain ranges and an electronic zero adjustment. The HIGH gain position is normally used to provide a means of scale expansion.

Controls and Connections

Described below are the functions of recorder controls and connectors.

1) HIGH-LOW Switch - This switch, located on the right hand side of the recorder, provides 2 ranges. The LOW range is set for the same full scale reading as the OVA readout meter. The HIGH range can be set to give an increased sensitivity to the recorder without effecting the OVA calibration.

2) ZERO ADJUST Knob - This potentiometer, located on the right hand side of the recorder, permits "nulling" of the background reading on the recorder without affecting the calibration of the OVA displayed on the OVA readout. In the full clockwise position, the recorder will display the same reading as the OVA meter. Counterclockwise rotation will reduce the reading on the recorder.

3) POWER CONNECTOR - This 126 series, 5 pin connector provides power and signal to the recorder, as follows:

PIN	FUNCTION
B	Input Signal
E	pos. 12VDC input
H	Ground

Calibration

Electronic and mechanical adjustments, other than the operational adjustments on the side panel, are provided to calibrate and align the recorder.
(See Figure 11).

MECHANICAL ZERO ADJUSTMENT

A) Snap out the front panel nameplate using a small blade screwdriver in the left hand slot) for access to mechanical zero adjust screw, place HIGH-LOW Switch in OFF position.

B) Unscrew knurled fastener at top of front panel to open recorder. Pull down plastic chassis latch on right side to release sticker bar tension on paper and adjust mechanical zero as required. Replace nameplate, chassis latch and resecure front panel.

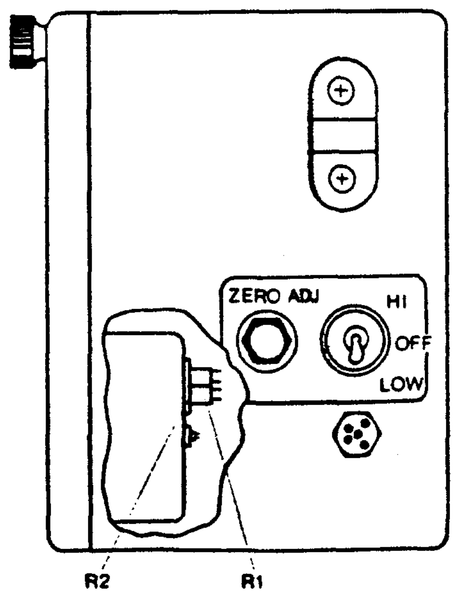


FIGURE 11
RECORDER CONTROLS AND ADJUSTMENTS

GAIN ADJUSTMENT

Separate adjustments are provided for the HIGH and LOW ranges on the recorder. (Refer to Figure 11 for location).

a) Connect recorder to OVA and adjust OVA for full scale reading on readout (about 5 VDC).
b) Loosen knurled fastener on upper left of the front panel and pull front panel down.
c) Place HIGH-LOW Switch in LOW and adjust R1 until recorder prints full scale.
d) Place HIGH-LOW Switch in HIGH and adjust OVA to read the desired full scale with front panel CALIBRATE ADJUST Knob, typically half scale on the readout. Adjust R2 until recorder reads full scale. NOTE: Full scale adjustment of the recorder for 1/2 scale on the OVA gives a gain increase of two (2) in the height of the peak on the chromatograms. This is the factory set point for the HIGH gain range; however, other points can be set as desired with a gain of three being the maximum obtainable without amplifier loading.

Maintenance and Routine Operations

Refer to the manufacturer's (Gulton) manual on the recorder which is enclosed with each recorder when shipped.

The recorder is equipped with a 16 RPM motor which gives a writing speed of four (4) strikes per second. The chart advance speed is determined by the gear train assembly used. Number 1 and 3 gear trains are provided. The chart advance speed for the Number 1 gear train is 8 in. (20.3 cm) per hours; for the Number 3 gear train, chart advance speed is 24 in (61 cm) per hour.

Changing Chart Speeds

To change the paper speed, open the recorder, remove gear box spring (on left side), move gear box in direction of arrow on its case and lift out from top. Do not force out from bottom. Insert new gear, bottom first, slide into position against arrow direction. Replace gear box spring.

Activated Charcoal Filter Accessory

The Activated Charcoal Filter Assembly is an accessory which can be installed on the OVA Readout Assembly. The filter is typically filled with activated charcoal which acts as an absorbent and effectively filters out organic vapors other than methane or ethane.

A screw cap on the probe end is removed for refilling the filter with activated charcoal or other filtering media.

Applications of the filter include:

1) Obtaining a clean air sample for zero baseline check and adjustment.

2) Running "blank" chromatograms to assess instrument contamination.

3) Rapid screening of methane and non-methane organic vapors.

4) Selective screening for natural gas surveys.

5) As a moisture filter when filled with a desiccant such as silica gel.

A press fit adapter on the back of the filter assembly is removed when installing the unit on the telescoping probe. When replacing the cap end after refilling, one wrap of ¼ inch teflon tape should be used to seal the threads.

The life of the filter will depend on the time in use and the concentrations of the compounds being filtered. Under typical industrial air monitoring conditions, the filter will last for many days of continuous sampling. See Figure 12.

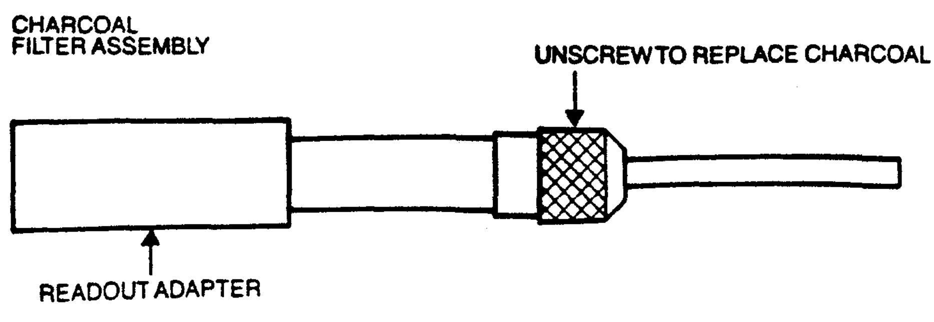


FIGURE 12
ACTIVATED CHARCOAL FILTER ASSEMBLY

Sample Dilutor Accessory

An adjustable sample dilutor assembly, P/N 511745-1 is an accessory. The dilutor is supplied with a 10:1 dilution orifice as standard. Orifices for 25:1, P/N 511770-2, and 50:1, P/N 511770-3, dilution are also available.

In operation, the dilutor is attached to the end of the telescoping probe or connected by external tubing to the input fitting of the OVA side pack. Dilution of the air being monitored is accomplished by stream splitting through the use of a needle valve on the sample input. An activated charcoal scrubber is inserted in the main air supply line to the OVA and scrubs the air of organic vapors. It also creates a slight vacuum at its output side of the scrubber and the vacuum at this point draws the sample air through the needle valve where it mixes with the main air supply going to the OVA detector.

The dilution valve provides a means of sampling vapor levels above the lower explosive level (LEL) and in oxygen deficient atmospheres. These conditions can occur in normal leak or source survey as the operator gets close to the leak or vapor source or in monitoring various manufacturing or material handling processes. Approximately 14% oxygen is required to sustain operation of the FID in the OVA.

Setting Dilution Rate

Prepare a sample in a bag at a high level, typically 1,000 to 5,000 ppm. Any suitable gas can be used, such as butane from a cigarette lighter; however, a compound similar to those to be measured provides greater accuracy. The actual concentration of the gas does not have to be known, since the dilution rate is simply a relative level.

Obtain an OVA reading on the vapor sample with the dilution valve removed. Then install the valve, loosen the jam nut and turn the needle valve until the meter reading corresponds to the original reading divided by the dilution factor desired. Retighten the jam nut.

It should be noted that when the dilution valve is used for natural gas leak survey and pinpointing, the charcoal filter will not remove the methane from the dilution air supply. Care should be taken so that natural gas is not allowed to enter the main air inlet. (See Figure 13).

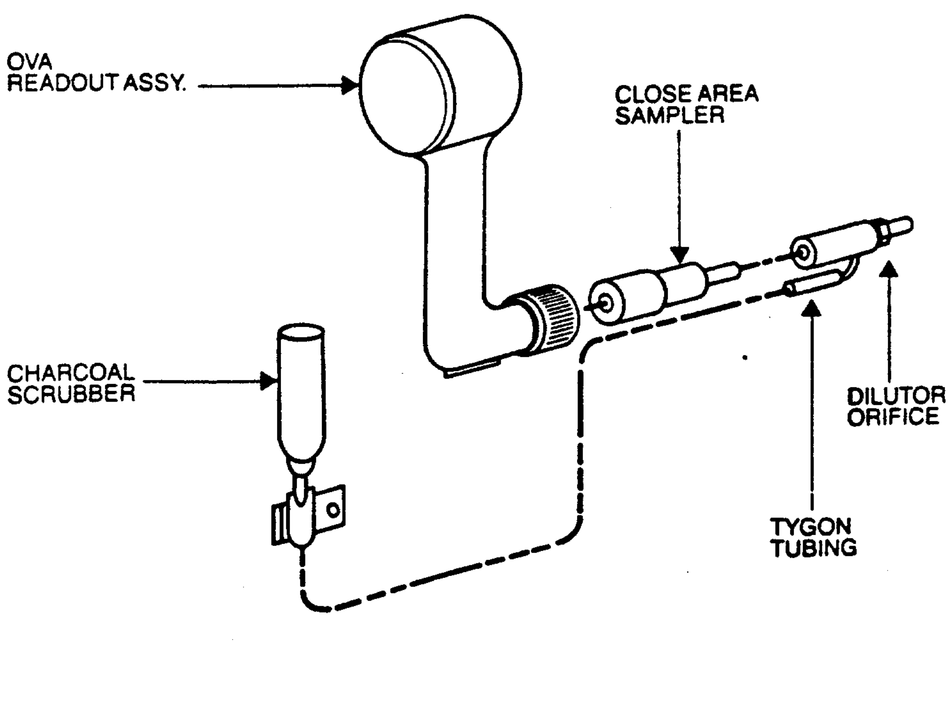


FIGURE 13
OVA SAMPLE DILUTOR

OVA Septum Adapter Accessory

A septum Adapter, P/N 510645-1, is available for direct on-line sample injection to the GC column inlet. The Septum Adapter mounts directly on the OVA front panel and sample injections from .025 to 2.5 mL may be made using a gas tight syringe.

This provides a range of sensitivity of approximately 10% to 1000% of the OVA standard valve, which has a sample loop volume of approximately 0.25 mL Syringe injection can cause flame-out, however, the OVA may be reignited after the injection is made. The air in the sample must elute from the column before reignition. The time for the air peak to elute is a function of the column length and the volume of the sample injected. For example, a 1 mL sample into a 12" column will require approximately 5 seconds; and, a 2.5 mL sample into a 48" column will require approximately 20 seconds.

The Septum Adapter also provides a means whereby samples from oxygen deficient atmospheres or process steams can be injected directly into the chromatograph. Headspace analysis may also be accomplished using the Septum Adapter and a syringe.

OVA Portable Isothermal Pack (PIP) Accessory

A column can separate an exceptionally wide variety of components if the separations are made at different temperature ranges. In addition, peak heights and retention times can vary with column temperature. The PIP option was developed to control column temperature, without affecting the analyzer's intrinsic safety specifications and without compromising the analyzer's portability.

When the Septum Adapter is installed on the OVA, the normal GC sample valve may still be used alternatively with the syringe injection. In addition to variable sample size and sensitivity, syringe injections will normally provide greater symmetry and reduce tailing of chromatogram peaks as compared with the standard valve injection.

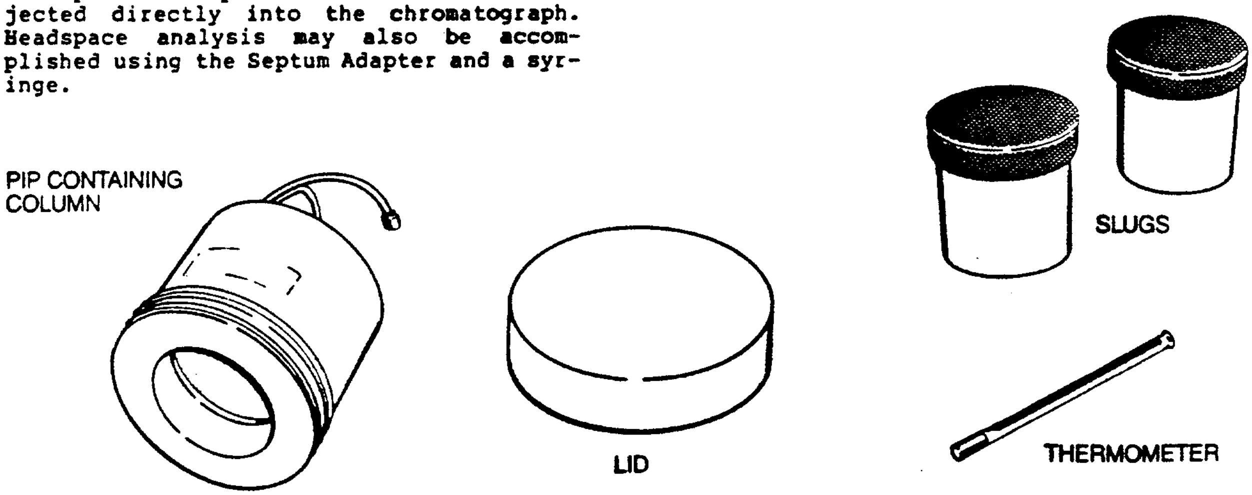


FIGURE 14
PORTABLE ISOTHERMAL PACK

PIP Components & Spare Parts

511800-1	PIP Kit
511805-1	PIP Assembly (specify column length and packing material)
511810-1	40°C Slug (phase-change material)
511830-1	Seeder for 40°C Slug
511815-1	Aluminum Slug
511820-1	Empty Bottles (package of six)
511825-1	Insulating Cover
511826-1	Thermometer

PIP columns can be prepared with any standard column packing material. A temperature control slug is inserted into the PIP slug cavity which has exterior foam insulation. For field operation in extreme ambient temperatures, an additional sheepskin jacket can be installed. The period of temperature control depends upon the temperature difference between ambient and the slug. For a 0°C ice pack and ambient temperature of 27°C, a control period of approximately 10 hours is typical. Additional information on the PIP system will be found in Foxboro document TI611-105.

Notes

Notes

Notes

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